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"Sawing Wood"

Circulating Water for Ashley Street Station

By JOHN HUNTER
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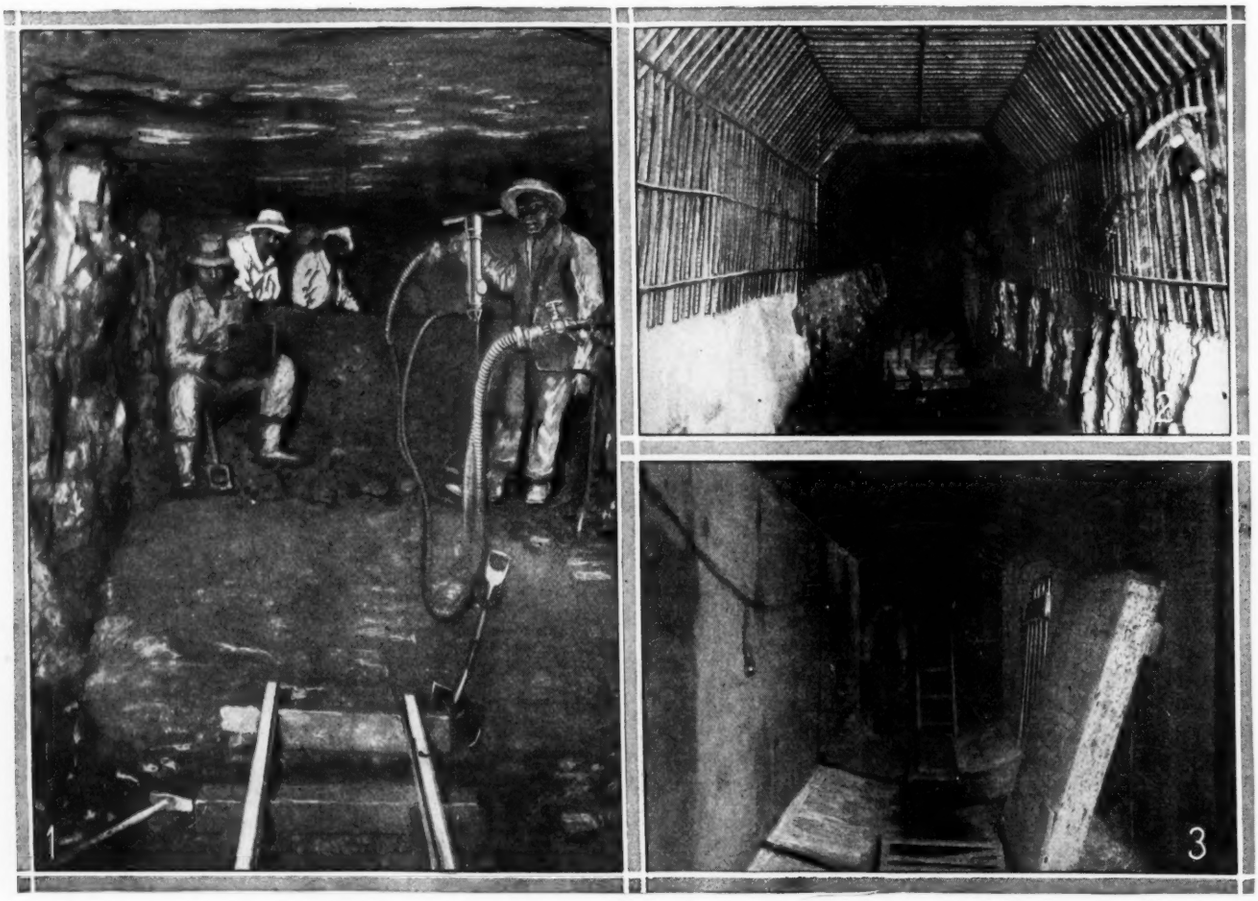
Unusual difficulties were met in the building through solid rock of new intake and discharge tunnels having a maximum capacity of 300,000,000 gal. per day. Revolving screens on 53-ft. centers form a feature of the new work.

IN a previous article dealing with the new development of the Ashley Street Station of the Union Electric Light and Power Co., of St. Louis, mention was made of new circulating-water tunnels which it was found necessary to build for supplying cooling water to the surface condensers of the new equipment. The present article will describe briefly some of the operating and construction features of the new tunnels.

All the condensing equipment for the generating units in this station is supplied with water pumped directly from the Mississippi River, upon the banks of which the station is situated. The original arrangement of intakes and circulating-water piping was only of sufficient capacity to supply about half of the requirements of the station when expanded to its ultimate capacity of 116,000 kw. The original system consisted of openings through the east river wall of the building as outlined in the left-hand part of section *AA*, Fig. 5, there being two gates in each of the two intakes, the upper for use during high stages of the river and the lower for use during lower stages. Pipes of 36 and 42 in. diameter carried water from these intakes across and below the basement of the boiler room, five pipes supplying water to a common 54-in. suction header. This header supplied water to the suctions of two 70,000,000-gal centrifugal pumps, which in turn discharged the cooling water to the surface condensers through a common discharge header. The engines driving these centrifugal pumps are tandem-compound and develop 1000 indicated horsepower.



FIGS. 1 TO 3. SHOWING STRUCTURE, REINFORCING AND INTERIOR OF WATER TUNNEL
Fig. 1—Structure of rock in tunnel heading. Fig. 2—Reinforcing Steel in outer lining. Fig. 3—Interior of completed tunnel

In the new development of the station three additional 25,000-kv.-a. turbines are being installed. Each of the condensers serving these units has 40,000 sq.ft. of cooling surface requiring 50,000,000 gal. of circulating water per day under full load and normal river temperature. To supply this additional 150,000,000 gal. per day necessitated the rearrangement of the circulating-water system and the building of new intakes.

The general arrangement of this new circulating-water system with reference to the original system and

the difficulties that were involved in carrying out the work without interrupting the operation of the generating units may be seen by reference to Figs. 4 and 5.

The arrangement decided upon involved the abandonment of the old discharge lines returning the circulating water from the condensers to the river. This was made necessary because the river end of these pipes was in the exact location at which new intakes could be located to the best advantage. Also these outlets were at a point too far upstream with reference to the general arrangement of intakes, the logical point for the outlet being at the extreme downstream end of the plant. The new circulating-water discharge therefore was so located and made of such size that it would carry the water from all generating units and discharge it into the river at the extreme downstream end of the plant.

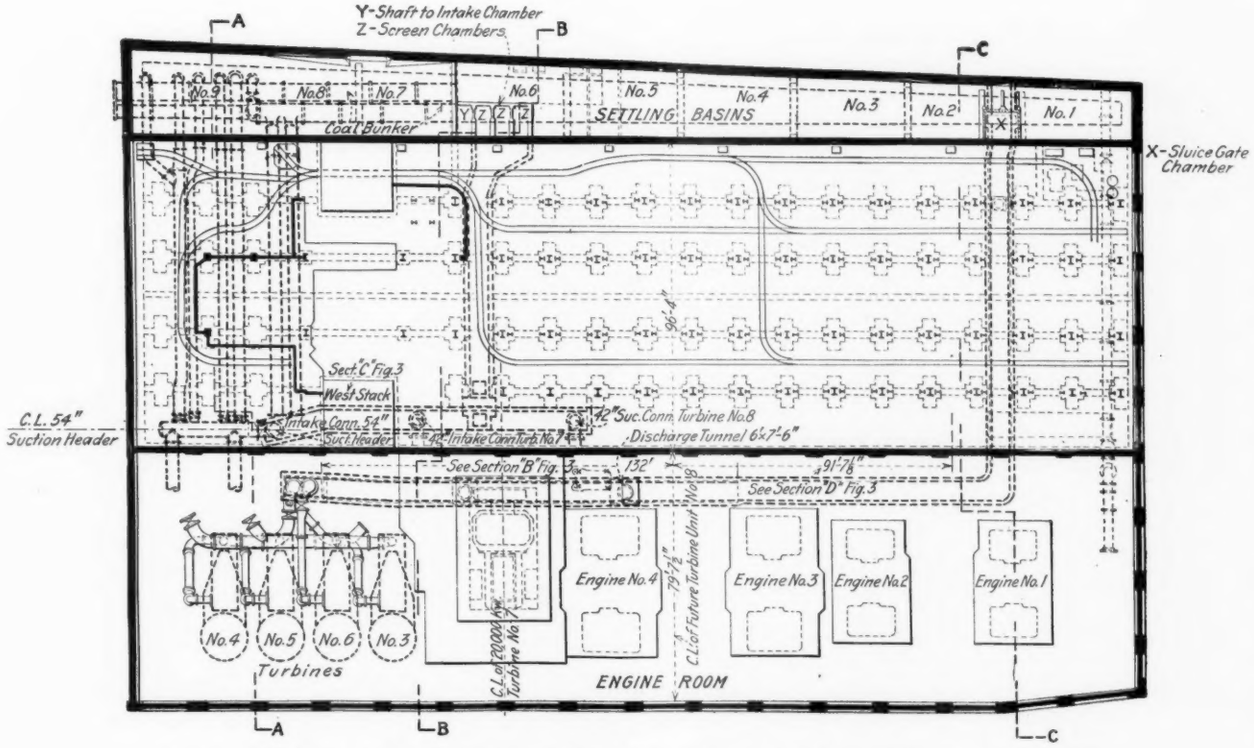


FIG. 4. GENERAL PLAN OF STATION, SHOWING CIRCULATING SYSTEMS, NEW AND OLD

It was early decided that all new circulating-water lines should be tunneled through the solid rock that underlies the station, these tunnels to be lined with reinforced concrete as the nature of the rock would require. The discharge tunnel was built first. Construction shafts were sunk at suitable places in the boiler room, and the tunneling in the rock was carried forward almost to completion without connection to the river end of the job. The contour of the rock through which this tunnel was driven, the general dimensions of the tunnel sections and the manner of reinforcing may be seen in Figs. 1, 2, 3 and 5. Practically all portions of the tube, whether opencut or tunnel sections, were built up with a 12-in. reinforcing concrete lining next to the rock, inside of which was laid four-ply waterproofing membrane made of high-grade roofing paper mopped into place with hot asphaltum. On the inside of this membrane was then poured a 4-in. reinforced-concrete lining, this being designed to protect the waterproofing and to take up all manner of wear within the tunnel.

The concrete for the tunnel lining was mixed in the boiler-room basement and delivered to a one-yard bucket mounted on rails within the tunnel and from it poured by hand into the forms. The concrete for the roof of the arch, after having been thoroughly tamped into place and set, was found to have settled away from the roof of the rock, leaving an opening in some cases ¼ in. wide. This opening was filled and the bond made solid between the roof of the lining and the rock by use of the cement gun. At intervals of about 10 ft., a 2-in. hole was drilled in the roof of the tunnel and thin grout forced into the openings under 60-lb. air pressure, with the result that the opening was completely filled and a strong bond established between the rock and the concrete tunnel lining. The construction costs on this tunnel were approximately $14 per linear foot for excavation and $5.50 per linear foot for concrete linings, including forms.

Simultaneously with the excavation beneath the building, work on the river end of the discharge tube was being carried forward. This involved the building of a chamber which should contain the 6 x 8-ft. sluice gate, Fig. 6, also the opening up of proper space outside of the river wall for the tunnel outlet. Extensive dredging and excavation of the river bed was required to clear a space of sufficient area for this tunnel outlet.

In cutting through this river wall the method followed was unique. An open caisson, Fig. 7, was sunk on the river side of the outer wall to a depth of approximately 40 ft. below the water level. This caisson was built up of heavy timbers and steel of sufficient strength to withstand the hydraulic head. The edges were heavily cushioned (see Fig. 8) so that when

brought up tightly on the outer concrete wall, they would make a water-tight joint. Pumps were installed inside of this caisson, and when all preliminary work had been completed and the water withdrawn, the tunnel excavation was extended out, and into the caisson. The services of a diver were continuously required in connection with this work, his duty being to place the dynamite for loosening up rock preparatory to dredging and later on to take care of leaks in the caisson.

One of the most difficult operations in connection with the new discharge-tunnel work was the cutting over of the four 12,000-kw. turbine condenser discharge lines into the tunnel without interrupting the service of the station. These connections are 42 in. diameter, and the preliminary work of setting the nozzles, piping, valves and fittings for the cut-over had to be accurate to insure a successful consummation of the work. Renewing the old portions of the 42-in. headers and replacing them with other pipe and connections to the new tunnel had to be done between the hours of 1 o'clock on Saturday night and 4 o'clock on Sunday afternoon. One seam of rivets in each of the 42-in. elbows was left undrilled to insure against possibility of misfit, and it was the drawing up of this pair of old basement floor. It was necessary while driving this tunnel to blast out shafts and insert castings for the reception of future discharge connections from the new turbines.

It will be seen from the general elevations shown in Fig. 5 that the suction tunnel from the new intakes

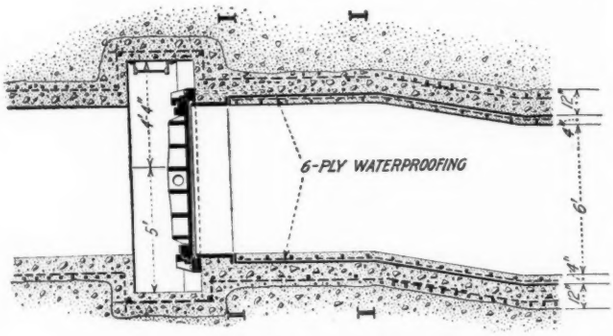


FIG. 6. SLUICE-GATE SETTING

into the new suction headers is approximately at the same elevation as the new discharge tunnel, both of which are at an elevation of some 10 ft. below the suction header of the old circulating-water system.

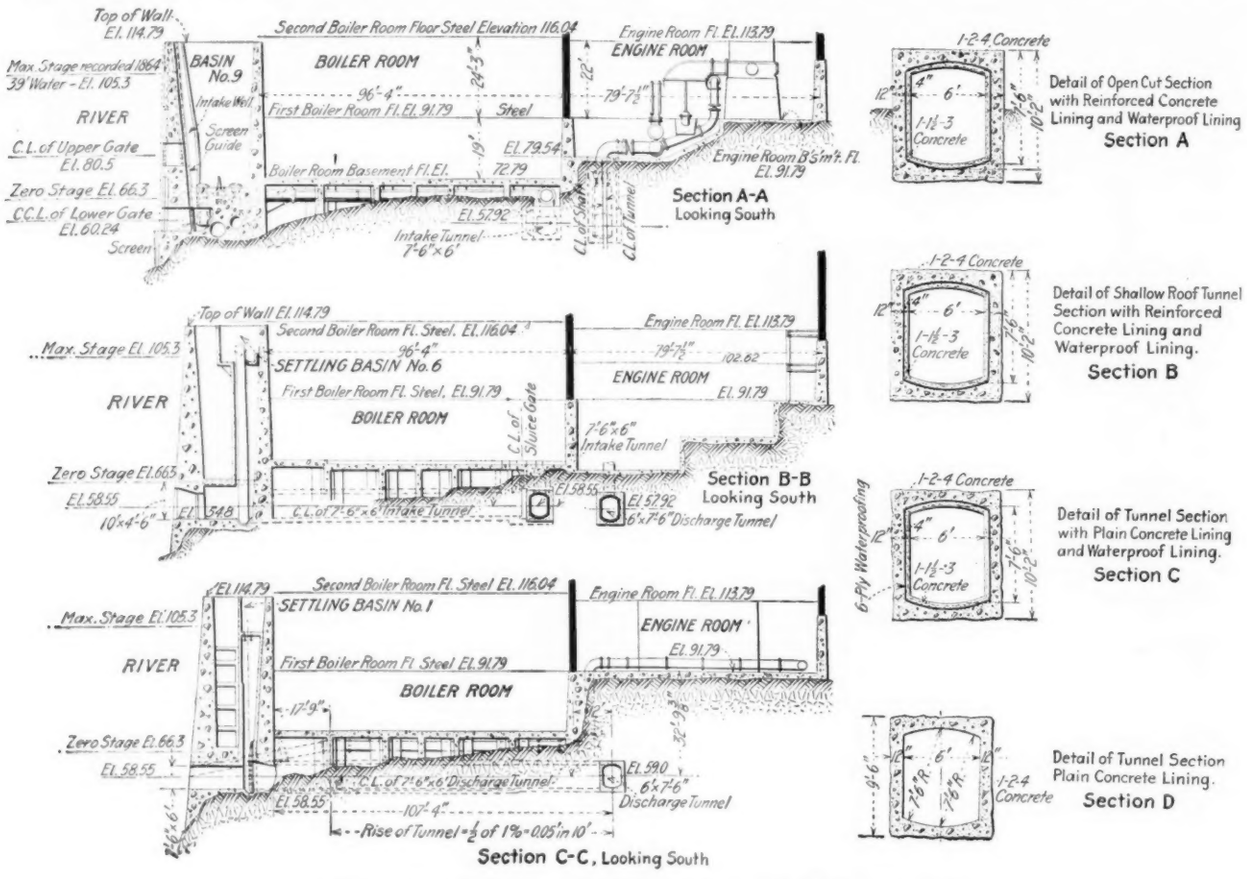


FIG. 5. SECTIONAL ELEVATIONS, SHOWING NEW TUNNELS

plates, the drilling of new holes and the driving of rivets that occupied a large portion of the available time. Suffice it to say that both of these connections were successfully made without interrupting the service of the station.

This discharge tunnel, which runs practically the full length of the station, lies 33 ft. below the level of the

In building the new intake advantage was taken of the fact that the plant has practically two outer walls (see Fig. 9), one the outer river wall and the other some 20 ft. inside and supporting the main east wall of the boiler house. The space between these two walls is divided into nine compartments and is used as settling basins for the water-purification system.

One of these basins was made use of as a screen chamber for the new intakes. Through the outer walls two new intake openings were blasted in a manner similar to that of the discharge tunnel already described and using the same caisson. On the outside of the openings heavy bar screens were built to keep out any heavy material or driftwood coming along with the river water. Inside of the same wall were placed two heavy sluice gates, each 6 x 6 ft. in section. These gates open into the screen chamber proper, which chamber was formerly known as No. 6 settling basin. In this chamber are three revolving screens operating across the three openings that supply water to the intake tunnel.

Unusual Construction Work

In connection with the building of these screen chambers and intake gates the construction work was difficult and interesting and of a character that seldom falls within the experience of central-station engineers. As mentioned before, advantage was taken of the fact that the discharge from the old circulating-water system was in close proximity to the site decided upon for the new intakes, and piping arrangements were so laid out and connected that it is now possible to discharge water from either one of the circulating-water systems back through the intakes of the other system, thereby flushing out all drift or sand, which is carried in suspension in the river water in great quantities.

Besides being situated in such a place as to furnish water to the three new 25,000-kv.-a. turbines, the new suction tunnel was connected in at one end of the cross tunnel, as shown in Fig. 10, to the 54-in. suction header of the old system. It is thus possible to supply water to any or all of the generating units in the station through either of the suction intakes. The elevations of the suction tunnels are such that it is possible to supply water to the circulating pumps when the river is 8 ft. below the zero stage, the lowest stage of the river ever experienced in the St. Louis district being 4 ft. below zero. Hence the station is well protected against the possible losses of circulating water at low stages of the river. Fig. 11 shows the bottom of the intake chamber, looking through one of the openings into the river. A protective bulkhead is shown across the river opening. Later, this was blasted out into the open caisson. The photograph shows the concrete and reinforcing ready for the setting of the sluice gate. The suction tunnel is figured for a maximum flow of 5 sec.ft. while pumping the maximum quantity of 300,000,000 gal. per day. This is approximately three times the quantity used by the entire city of St. Louis for all purposes.

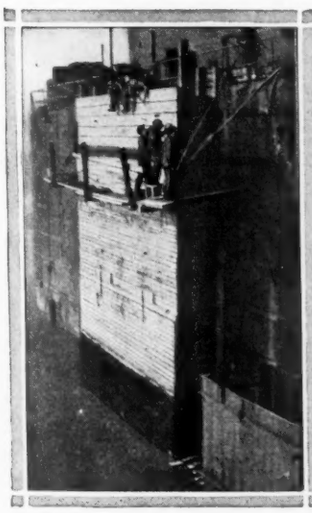


FIG. 7. OPEN CAISSON READY FOR LOWERING

FIG. 8. BOTTOM SECTION OF THE CAISSONS

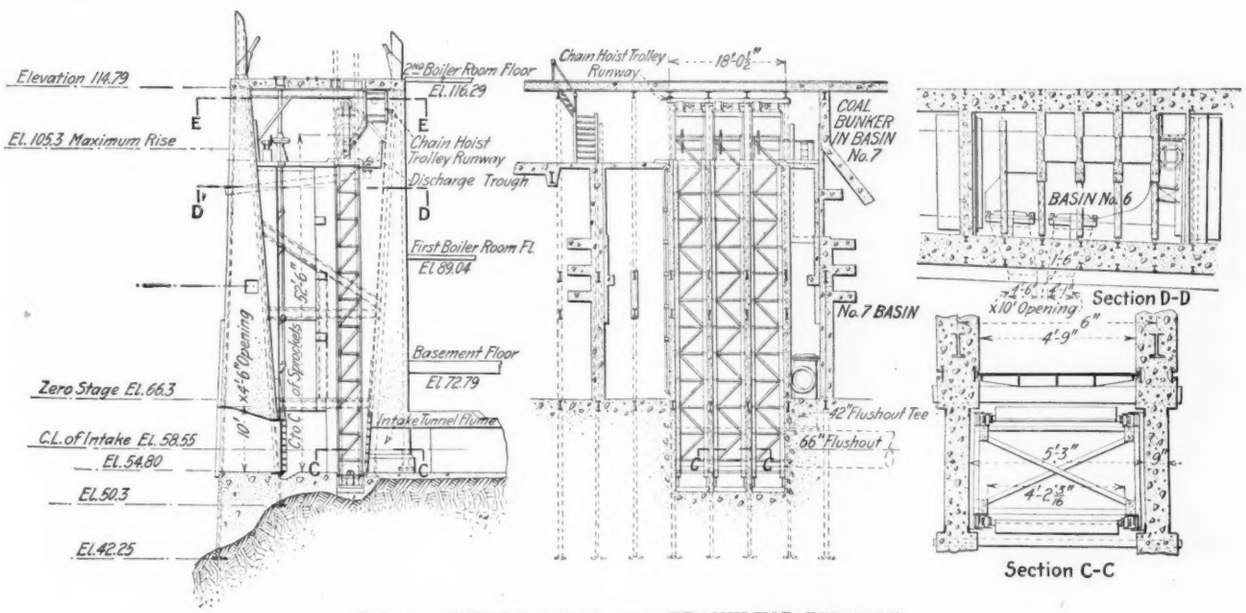
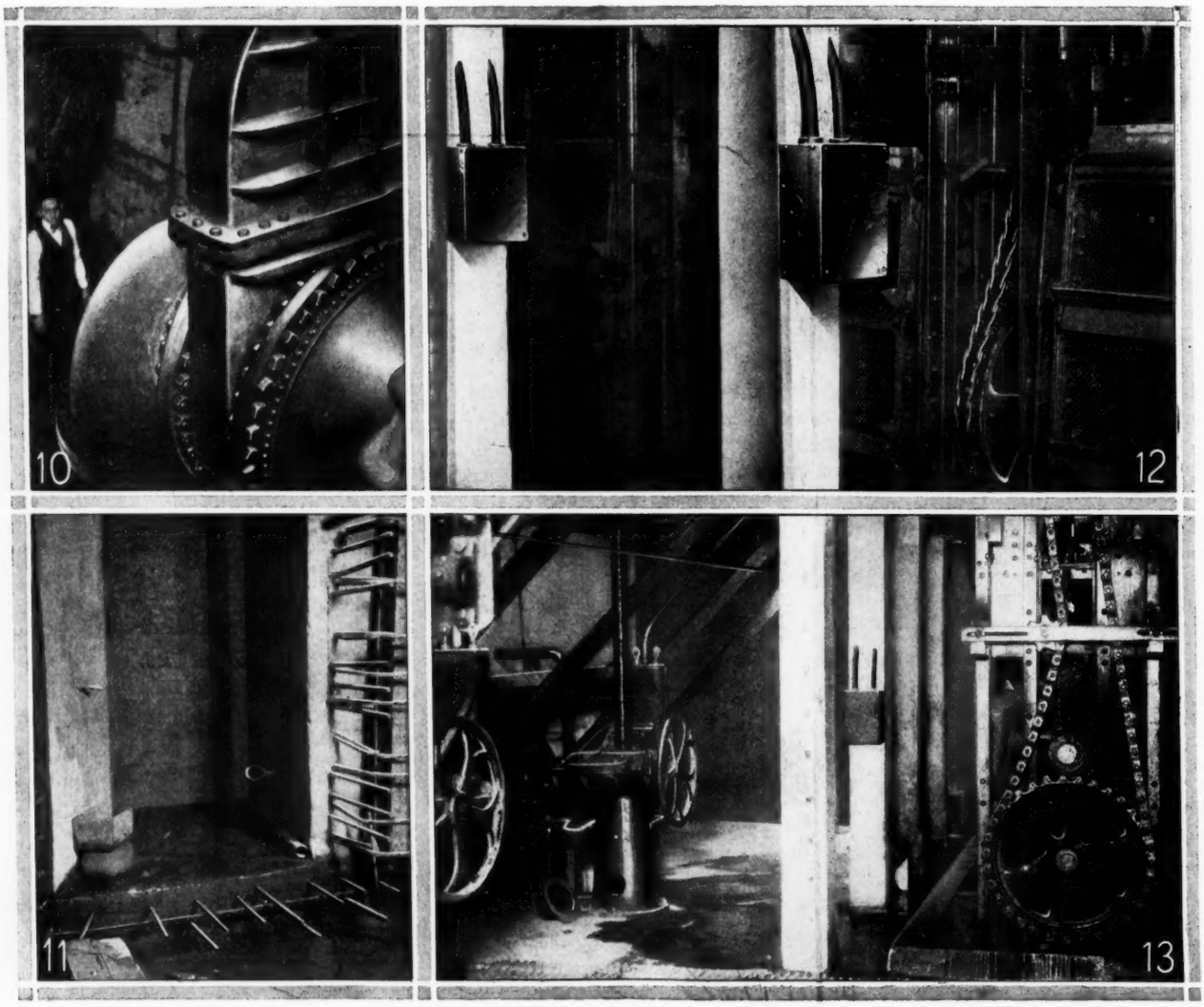


FIG. 9. INTAKE GATES AND TRAVELING SCREENS

The chain belt revolving screens shown in part in Figs. 12 and 13, used in connection with the new installation, are built on 53-ft. centers. At the time of their installation these screens were the longest that had ever been built for such purpose. The necessity

in this case was due to the wide range in the stage of the Mississippi River at St. Louis, this varying from —4 ft. to +36 ft. Changes as rapid as 6 ft. in one hour have been experienced. The original intakes of the station were equipped with screens mounted in frames, which were lifted and lowered by means of motor-driven cables, there being a pair of screens in front of each intake gate. The operation of the new screens, however, is so successful and fulfills the objects for which they were built to such good advantage that it is anticipated that the old sliding screens will be replaced by more modern revolving screens at an early date.

An interesting feature in connection with the operation of the new discharge tunnel is the fact that a marked siphon effect is obtained in the discharge lines from the turbines, thereby reducing the power required to drive the circulating-water pumps to an almost negligible quantity. During the extremely low stages of the river, however, it was found that this siphon is less effective owing to the carrying in of considerable quantities of air with the circulating water. At the higher stages of the river this is not noticeable.



FIGS. 10 TO 13. SOME OF THE APPARATUS USED IN HANDLING THE TUNNEL AND CONDENSING WATER

Fig. 10—Elbow and valve connecting old 54-in. suction header with new tunnel system. Fig. 11—One of the openings into river from intake chamber. Fig. 12—Chain-belt traveling intake screen. Fig. 13—Chain drive of traveling screen and sluice gate operating stands

Retubing Bent-Tube Condenser

By Bernard Wach

Some time ago we assembled a condenser with curved tubes in one of the Philadelphia shipyards, the curvature running one horizontal row right, the next left hand. One man would put a tube in at the front about half way, then another man would catch and direct it to the corresponding opposite hole; the first man drove it in slowly with a wooden hammer. The inspector found it necessary to change some of the tubes after the top had been finished. The tubes to be changed were in different sections, and the problem was how to put in the new tube after the old one was removed, there being no way to direct the new tube into the corresponding opposite hole.

We put a wire through the old tube, and after it was removed the wire served as a guide for the new tube. It happened once, through carelessness, that the wire was pulled out with the old tube. We then bent the end of a thin wire, and putting it in the front between the tubes, we finally pushed it through and into the corresponding hole at the other end.

Ten Years of Boiler Standardization

By JOHN A. STEVENS
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A review of the conception and final development of the boiler code that has been adopted by the American Society of Mechanical Engineers.

THE conception of a standard specification was, I believe, first advocated by Joseph H. McNeill, who for many years was chief inspector of the Massachusetts Boiler Inspection Department, and through the earnest endeavors of Mr. McNeill and the operating engineers of Massachusetts, most ably sponsored by the late Curtis Guild, Jr., governor of Massachusetts and later Ambassador to Russia, the Massachusetts Board of Boiler Rules was created. The original board consisted of Joseph H. McNeill, chairman; John A. Stevens, representing boiler-using interests; Frederick H. Keyes, representing boiler-manufacturing interests; Robert J. Dunkle, representing boiler-insurance interests; and William M. Beck, representing operating engineers. Upon the retirement of Frederick H. Keyes, Bartholomew Scannell, of Lowell, Mass., one of the patriarchs of the boiler industry in this country, was appointed in his place; upon Mr. Scannell's resignation, Henry H. Lynch was appointed. The late Thomas R. Armstrong was also a member of the Massachusetts Board of Boiler Rules at one time.

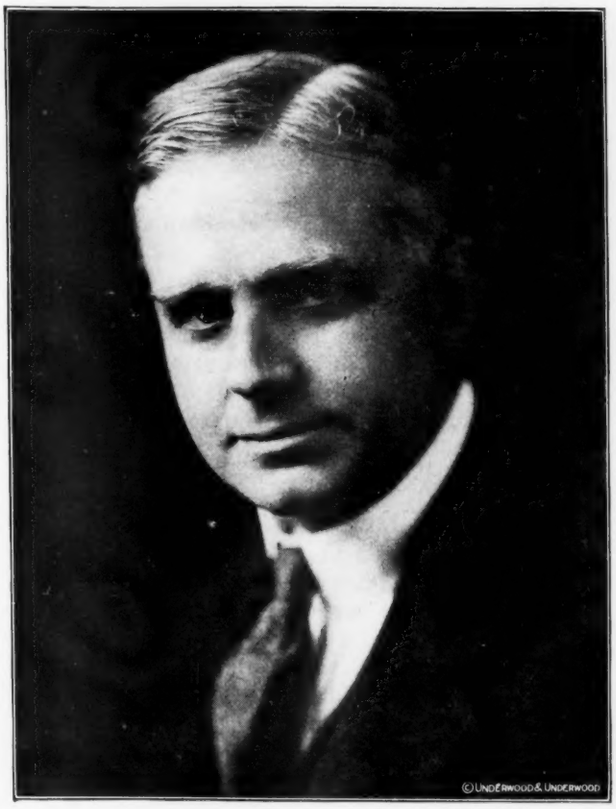
Massachusetts Standard Formulated

The first meeting was held July 5, 1907, in a very small and hot room on the fifth floor of the State House, Boston, at which meeting Mr. McNeill gave the other members of the board his ideas of a standard specification for all stationary boilers to be used within the Commonwealth. The board forthwith set to work to formulate a standard which would be first of all, safe, and second, commercial. Meetings were held weekly and oftener, for practically the first three years of the service. The correspondence was very prolific and came from all known authorities who could be interested enough to send in any good data which they had on boilers which would make the steam boiler of the future reasonably safe; almost without exception, prompt and efficient replies were received from all those well qualified to give advice.

From time to time as the board was in a position to do so, pamphlets of instructions to boiler manufacturers and inspectors were issued, stating how the rules should be applied in the construction of boilers, until the board published the issue of Aug. 5, 1909, which was the last and main one made by the original members of the Massachusetts Board of Boiler Rules and which issue embodied all that was necessary for the guidance of those manufacturing and inspecting stationary steam boilers for the Commonwealth of Massachusetts for that period.

While this work was going on, the forces in the inspection department were augmented, more rigid watch was kept of existing boilers and more thought, patience and skill were put into the manufacture of new boilers; in other words, the educational process was advanced and has advanced ever since Mr. McNeill started this system. In the meantime the writer made a trip abroad and interviewed several of Europe's greatest boiler engineers with special reference to additions or deductions from the rules, and the board was very highly complimented in Europe on the rules formulated.

The present Massachusetts Board of Boiler Rules, in addition to its boiler-standardization work, has formulated very valuable air-tank regulations. The board



JOHN A. STEVENS

consists of George A. Luck, chairman; Frederick A. Wallace, representing boiler-using interests; Henry H. Lynch, representing boiler manufacturing; Robert J. Dunkle, representing boiler-insurance interests (member of board since its conception); and Edward D. Mullane, representing operating engineers.

In 1911 the late Col. E. D. Meier, then president of the American Society of Mechanical Engineers, suggested in his far-reaching foresight that the society undertake the work of standardization of steam boilers in a more complete manner than was possible with the State of Massachusetts, and the writer was appointed chairman of the original committee of the American Society of Mechanical Engineers for the purpose of creating a standard for that society. This committee was called "The Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for their Care in Service," and originally consisted of John A. Stevens, chairman;

William H. Boehm, Rolla C. Carpenter, Richard Hammond, Charles L. Huston, Edward F. Miller, and H. C. Meinholtz (deceased). Upon the death of Mr. Meinholtz, Col. E. D. Meir was appointed in his place.

Colonel Meir took a most active part in the formation of the A.S.M.E. Boiler Code and up to within a few days of his death had it constantly before him. It is one of the regrets of the members of the committee that he could not have lived to see the fruition of the work he so wisely started.

The committee proceeded on lines similar to those followed by the Massachusetts Board of Boiler Rules in counseling with all qualified authorities, manufacturers and large users of boilers, producing its preliminary report and thereafter issuing at different times other preliminary reports up to the issue which was given to the public in 1914.

At one stage in the work it was found advisable and necessary to amplify the original committee by appointing an advisory committee composed of some of the most celebrated steam engineers, for it was believed that the great interests of the country should not have "taxation without representation," and it has always been admitted that boilers built to the standard of the American Society of Mechanical Engineers cost more money than those built otherwise and are indeed worth more.

In appointing the advisory committee, men were chosen to represent all the large interests affected—such as railroads, consulting engineers, large manufacturers of different types of boilers, and engineering schools—thus bringing their keen interest in the promulgation of standards among engineering institutions, steam-heating boiler manufacturers, water-tube boiler manufacturers, boiler-insurance companies, threshing interests and boiler users.

Personnel of Advisory Committee

The members of this advisory committee consisted of the following: F. H. Clark, railroads; F. W. Dean, consulting engineers; Thomas E. Durban, Boiler Manufacturers' Association Uniform Specifications Committee, for all types of boilers; Carl Ferrari, National Tubular Boiler Manufacturers' Association; Elbert C. Fisher, Scotch marine and other types of boilers; Arthur M. Greene, Jr., engineering education; Charles E. Gorton, steel heating boilers; A. L. Humphrey, railroads; D. S. Jacobus, water-tube boilers; S. F. Jeter, boiler insurance; William F. Kiesel, Jr., railroads; W. F. McGregor, National Association of Thresher Manufacturers; M. F. Moore, steel heating boilers; I. E. Moultrop, boiler users; Richard D. Reed, National Boiler and Radiator Manufacturers' Association; H. G. Stott, boiler users (deceased); H. H. Vaughan, railroads; and C. W. Obert, secretary to committee.

In the appointment of the advisory committee, men were fortunately selected who proved to be real workers and who, moreover, were naturally possessed of analytical minds—men not afraid to admit when they were wrong and not afraid to be insistent when they were right.

Special mention is made of the great assistance given the committee throughout the early stages of the formulation of the A.S.M.E. Code by Henry Hess, vice president of the society, who counseled with and guided the committee with special reference to conferring with other large societies interested in the standardization work, notably the American Society for Testing Materials, and also other societies which were more or less interested in a boiler standard. He also wisely advised against having anything to do with legislation or politics, and had attempts been made to work through these channels, they would have caused the downfall of the Code early in its life.

Space prevents mentioning in detail the great assistance given by manufacturers of boiler material irrespective of their own desire to manufacture only one standard material for boilers, the great help rendered by the boiler-insuring interests and by the railroad interests of America and the large boiler users.

Throughout the entire formulating period of this work, the writer was most ably assisted by his associate engineer, Walter Slader, and credit is hereby given him for the valuable work he did throughout this long and arduous task. In passing, due credit should be given to *Power*, *The Boiler Maker* and several other engineering periodicals that have from time to time issued articles in sympathy with the movement.

A. S. M. E. Code Founded on Massachusetts Standard

The work of the Boiler Code Committee of the American Society of Mechanical Engineers was founded on the standards originated by the Massachusetts Board of Boiler Rules, but is much more complete and far-reaching than the Massachusetts standard. In the first place it specifies in detail the chemical and physical properties of all material entering into the construction of boilers and gives rules, formulas and tables that have been checked and rechecked by men of national reputation and in many cases verified by testing laboratories; that is to say, in many cases, rules or formulas were withheld until actual tests in laboratories were made in order to prove the mathematics.

The Code has been adopted, or is in the process of adoption, by the states of New York, New Jersey, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, Minnesota and California, and by such cities as Kanses City, Scranton, Penn., and St. Louis, Mo., and even in Argentina and Paraguay, South America. This would indicate that the Code has been through a severe process of trial and has been found to be, as stated, the best in existence for governing the construction and inspection of stationary boilers. Furthermore, according to Specification No. 2362 for power-plant equipment at the Naval Training Station, Newport, R. I., boilers and accessories used by this department are to be in accordance with the A.S.M.E. Boiler Code.

In regard to the cost of this work, it is interesting to review the enormous amount of money spent directly and indirectly by the engineers having to do with the standardization of boilers in America. It was stated authoritatively in New York at the completion of the "A.S.M.E. Boiler Code, Issue of 1914, with Index," that the work, if paid for at ordinary professional rates, would have cost at least a quarter of a million dollars. Further, it was said by a member of the Boiler Code Committee in New York recently that by the time the Code is universal in the United States, the cost will run close to a million dollars.

The policy of the American Society of Mechanical Engineers does not permit its members or the members of its committees, as representatives of the society, to have anything to do with projects political or commercial, and through the foresight of Thomas E. Durban, the American Uniform Boiler-Law Society was created, the officers of which are: Thomas E. Durban, chairman administrative council; E. R. Fish, American Boiler Manufacturers Association; H. P. Goodling, National Association of Thresher Manufacturers; F. W. Herendeen, National Boiler and Radiator Manufacturers Association; M. F. Moore, low-pressure steel boiler manufacturers; I. Harter, Jr., water-tube boiler manufacturers; John H. Wynne, locomotive manufacturers; Walter Plehn, steam shovel manufacturers; H. N. Covell, hoisting-engine manufacturers; Charles S. Blake, boiler-insurance companies; John Hunter, National Electric Light Association; and D. J. Champion, boiler materials.

Mr. Durban advises the writer that they have expended on an average of $1000 per month since they started on the work of interesting the states to adopt the A.S.M.E. Code. This money is being spent to bring the Code prominently before the people and to explain its advantages.

American Boiler Code Congress

On Dec. 4 and 5, 1916, the American Boiler Code Congress was held at Washington, D. C., where the official representatives of 23 states were present, and it was unanimously voted to approve the Code of the American Society of Mechanical Engineers.

The Code also had a very able sponsor from Toronto, Canada, in D. M. Medcalf, chief boiler inspector of Ontario, who is fully alive and awake to the advantage of having the same code in vogue in the Canadian provinces as in the United States.

For those who do not know, the idea of "standardization" is strictly American, being an American creation; for instance, the standard firehose coupling, the standard berry basket, the standard electric-lamp socket, the standard cement specification, standard structural shapes, standard screw threads, and of late, the standard ship; and a standard boiler construction using one standard of boiler materials and accessories would naturally appeal to the highest and broadest type of business men in the spirit of maximum conservation and efficiency.

For the states that have not adopted a standard, the only work that is necessary is of an educational nature; for when the entire case is fully explained, the Code is usually adopted. For those states that have not adopted the Code the writer would recommend it as being the most complete boiler law of any in existence at the present time.

Further, a permanent committee has been established by the American Society of Mechanical Engineers for adding to and deducting from the Code as the art advances, and also to assist in its interpretation in states and municipalities where the engineers are not conversant with its rulings. In other words, the society very advisedly is in a position of a "clearing house" for boiler engineering.

The writer's thought has always been to have the Code so complete that all that was necesary in ordering boilers was to name the type, amount of heating surface required and the working pressure desired, and where credits and reputations are good, a postal-card order might suffice, since the fact that a boiler has been properly stamped with the symbol of the American Society of Mechanical Engineers would be positive proof that all the purposes of the contract and every detail of the Code requirements were fulfilled.

The Code is the result of the combined ideas of several thousand engineers who have assisted the committee from the start up to the present time in producing the right recommendations.

The Code is now under its first revision, and the revised printing will be ready for the public within a few months. The proposed revisions are being published from time to time in the Journal of the society with the idea that all those interested may be given an opportunity to discuss them before they are brought to their final form for adoption. The greater part of the revisions will be made to clarify the text and not to change the intent of the original Code.

The writer has often been asked how many boilers there are in America, to which he would answer that as near as he can glean, there were about 600,000 power boilers in 1914. It may be added that the boiler business in America is said to amount to $500,000,000 of products per year. These figures, however, are subject to revision by anyone who knows the facts. It will probably take another five to ten years to standardize boilers in America.

The Standard Airplane Motor

The new aviation engine, known variously as the "Standard," the "U. S. A." and the "Liberty," has become a reality and is perhaps the best example of intensive designing, building and testing of which we have any knowledge. It shows what can be done when engineers who thoroughly understand not only designing, but manufacturing, are placed in charge of such important work. The first motor was built and in running condition in one month from the time the drawings were begun; the designing had of course been largely accomplished before this, except as to details that came up as the final drawings progressed.

Without going into technical details as to the construction of the engine, which is not desirable at this time for various reasons, we may say that, as previously mentioned, it is an excellent example of what may be called "unit" construction. This refers not only to the cylinders, which can be combined on any size of engine base that may be desired (four, six, eight or twelve cylinder, or even more), but also to the parts such as valves, pistons, connecting-rods, valve-gear, oil-pumps, water-pumps and the like, all of which can be made in quantity and assembled as wanted.

In common with most of the high-grade and light-weight engines, the cylinder is of steel, made from a special forging instead of from the solid billet, as in the case of the Gnome. This is also true of some of the other parts, the question of rapid and economical manufacture evidently being always foremost in the minds of the designers, who deserve the utmost credit. The cylinders are set at 45 deg. instead of the 60 or 90 deg. to which we are usually accustomed, and the en-

gine as a whole has a clean and workmanlike appearance that is a joy to the engineer or mechanic who is familiar with this kind of work.

As befits a thoroughly modern engineering product, welding plays a large part in its construction, this being particularly true of the water jackets, intake and exhaust connections and of the exhaust manifold. The ignition system is particularly interesting and is one of the indications that the designers have not been hampered by tradition in any way. The oiling system is also of interest and shows a development that is both simple and efficient, using forced feed in its simplest form and, incidentally, being very economical of oil.

Rigorous tests have been made on a number of these engines under all sorts of trying conditions, including long endurance runs, tests at high altitudes and other conditions which thoroughly test not only the power, but the staying qualities, of the new engine. All these tests have proved more satisfactory than seemed possible with a new product, although it of course is not "new" in the sense of being untried as to principles, for it combines the best practice of all previous engines of this type.

And, best of all, it is probably the lightest engine yet produced, being about 2 lb. per hp., and is so designed that it can be produced in enormous quantities in a large number of shops that are accustomed to large production of high-grade machinery. The designing and development of this engine form one of the most creditable pieces of work which has yet been accomplished, and we hope to be able to credit the designers by name at some future date. Such achievements are just as praiseworthy as many of a more spectacular nature, and should go down in the annals of the war just as much as other accomplishments that certainly play no greater part in its successful prosecution.

Magnet-Type Elevator Controller

By J. GINTZ, JR.

The construction, operation and wiring of a magnet-type controller for an electric elevator are described.

FIG. 1 shows an Otis type No. 3F magnet controller. On this type of controller the reversing switches are controlled by electromagnets that are operated from a master switch in the car. The contacts on the reversing switches, marked up and down, which control the direction of the motor, are self-adjusting so that they make full contact on closing. These switches are constructed so as to prevent rebounding when they close, and the contacts are equipped with blowout magnet coils that limit the arcing.

The other switches on the controller are known as the potential or main-line switch *P*, accelerating magnet switch *A*, for cutting out the armature resistance, and the fast-speed magnet *S*. The coil on the potential switch is in series with all the safety switches, therefore will drop out when any of the safety devices open. The reversing switches have an extra contact 9, which controls the brake circuit. The fast-speed magnet *S* is arranged with one contact arm that, when in its normal position, closes the circuit for the extra-shunt field on the motor and is controlled from the last points F_d and F_u on the master or car switch, Fig. 2. When this circuit is energized, the contact arm of the fast-speed magnet is drawn in and the extra-shunt-field-winding circuit is broken, which will cause the motor to attain high speed.

On the accelerating magnet there are four contact arms which are staggered so that each one is set a little farther from the coil than the preceding one, No. 1′ closing first and the others following in order. The accelerating coil is connected across the motor's armature so that, as the latter increases in speed and the voltage across its terminal increases, the current to the accelerating-magnet coil will also increase and close the contact arms one after the other. In this way the starting resistance and the series-field winding are cut out, after which the motor operates at full speed as a shunt machine.

The stop-motion switches, Fig. 2, are mounted above one of the drumshaft bearings, are operated by cams

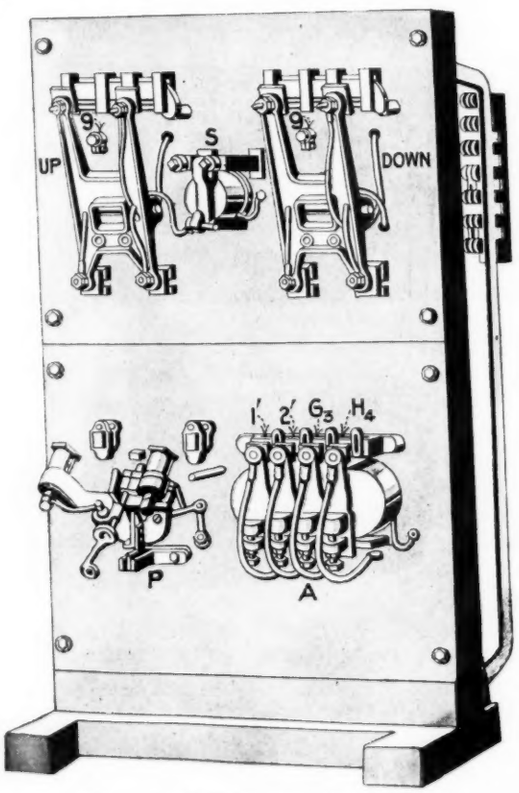


FIG. 1. MAGNET-CONTROL PANEL

geared to a traveling nut on the end of the drumshaft, and are used to stop the car at the top and bottom landings. The stopping is accomplished by two contacts for either motion. When No. 1 switch opens, the circuit

of the fast-speed magnet is broken, and the extra-shunt-field winding is again put into circuit, causing the motor to run at slow speed. When the contact on No. 2 cam opens, the magnet-coil circuit of the reversing switch is opened. This will allow the switch to drop out, thereby stopping the motor.

The car or master switch, Fig. 2, controls the motion of the car. The points D_o and U control the magnet-coil circuits on the reversing switches, and the points F_d and F_u control the circuit of the fast-speed magnet S. The car switch is connected by a flexible cable to a junction box located on the side of the elevator shaft, midway between the top and bottom, and from here the wiring is run in rigid conduits to the controller.

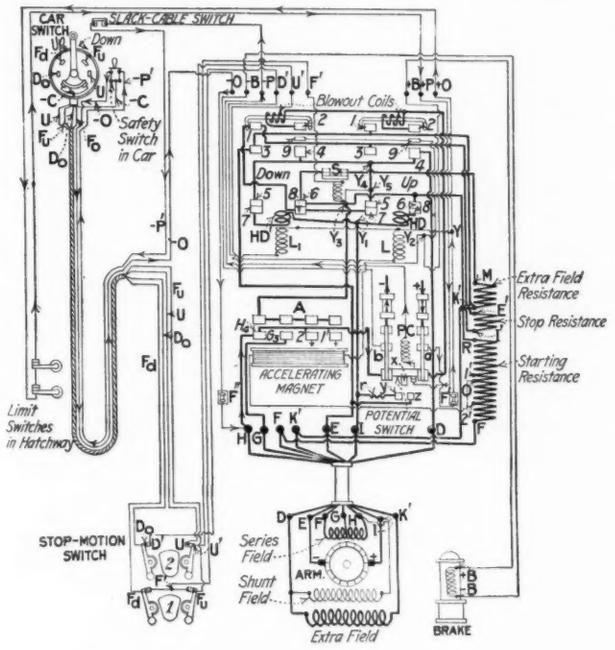


FIG. 2

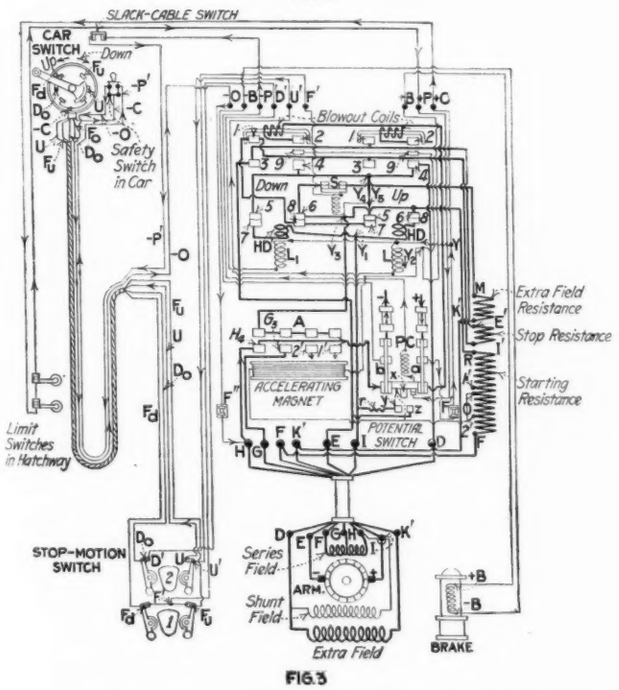


FIG. 3

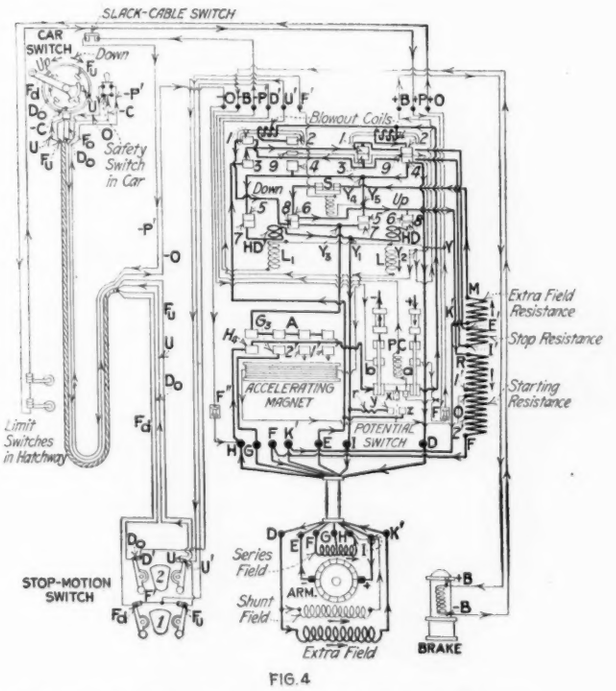


FIG. 4

FIGS. 2 TO 4. SHOW THE CIRCUITS ENERGIZED IN THE CONTROLLER, FIG. 1, TO START THE MOTOR

On a magnet controller there are two sets of circuits, the auxiliary and the power circuits. Both of these circuits are protected by fuses; and should a fuse blow in one or the other, the motor will stop. The fuses protecting the auxiliary circuits are of small capacity, as these circuits require only a small amount of current to operate the various elements. The power circuits are protected by fuses heavy enough to carry about 50 per cent. more than the full-load-current rating of the motor.

The auxiliary circuits consist of all the wiring for the magnet coils of the reversing switches, the fast-speed magnet, the no-voltage release coil on the potential switch, the upper- and lower-limit switches, the governor and slack-cable switches, and the safety switch in the car. The power circuit consists of the motor circuit—that is, the armature, shunt, series and extra-shunt field. With the exception of the shunt-field winding, all the power circuits are shown in heavy lines on the diagrams, and the auxiliary circuits in light lines.

Fig. 2 shows the wiring diagram for an Otis No. 3F magnet controller—all switches are in their normal position with the car at rest, but not at either the top or bottom landing. The only circuit that is closed is the potential switch. This circuit is from a on the positive side of the potential to the small fuse F', up to terminal $+0$, then to the hatchway-limit switches, and back to $+P$ on the controller, down through the potential-switch coil PC to terminal $-P$, through the slack-cable switch and the safety switch in the car, around through the fuse F'' and to terminal H on the controller, to H_1 on the accelerating magnet, and to the negative side of the line as indicated by the arrowheads. This circuit energizes the potential-switch coil and holds the switch closed.

When the operator throws the car switch on the slow up-motion position, as in Fig. 3, current will flow from

a terminal on the positive side of the potential switch to Y. Here the circuit divides. One path is through the safety devices and potential switch, as shown in Fig. 2. The other is through the magnet coil L on the up-motion reversing switch to terminal U' on the board. From here to U' on the stop-motion switch, all contact being closed, the current passes to U on the car switch. From this point to the switch lever, which makes contact between U and $-C$, from $-C$ to the bridge connecting the blades of the safety switch to -0 on this switch, back to terminal -0 on the control board, and to the negative side of the line, as shown by arrowhead. Energizing the coil on the up-motion reversing switch causes the latter to close, which makes contact between contacts 1 and 3, also 4, 9 and 2, and opens contacts 5 and 7, 6 and 8, as shown in Fig. 4.

Circuits Made by Up-Motion Switch

The closing of the up-motion switch completes five circuits—namely, the armature, which includes the series-field, the shunt-field, extra-shunt-field, accelerating-magnet and the brake-coil circuits. The direction of the flow of current is from the bottom terminal on the positive side of the potential switch to the blowout coil on the up-motion switch, through this coil to contacts 2, 9 and 4; from contact 4 to contacts 5 and 7 on the down-motion switch, and then through the hold-down coil HD' to point Y_1, then down to terminal I on the control board, and from here to one side of the armature, through the armature to terminal E and up to contact 3 on the down-motion switch to No. 1 and 3 on the up-motion switch, and back to 1 on the down-motion switch, then to 8 and 6, also on the down-motion switch, to R on the starting resistance, through this resistance to terminal F on the control board, which leads to one side of the series field; through the series-field winding to terminal H on the control board, to contact H_1 on the accelerating magnet, and to the negative side of the potential switch.

The shunt- and extra-shunt-field circuits are from contact 4 on the up-motion switch to terminal D on the controller board, down to one side of the shunt and extra-shunt field, where it divides, one circuit being through the shunt field to terminal H, from here to contact H_1 and back to the negative side of the line. The other circuit is through the extra-shunt-field winding to terminal K', from here to K' on the control board and to the extra-shunt-field resistance; through this resistance to M and to the fast-speed magnet S; from here to contact 6 on the down-motion switch and to R on the starting resistance. Through this resistance to F on the control board, and through the series-field winding to H_1 and back to the negative side of the line.

The accelerating-magnet circuit starts from contact 9 on the up-motion switch, down to point Y_2. At this point the accelerating-magnet and brake-coil circuits divide. The accelerating-magnet circuit passes to the accelerating coil, through this coil to point O on the starting resistance, through the lower portion of this resistance to terminal F, which leads through the series field to terminals H and H_3, back to the negative side of the line. The brake-coil circuit is from point Y_2 to terminal $+B$ and then through the brake-magnet coil, back to terminal $-B$ to the negative side of the line at b.

With the car switch in the position shown in Fig. 4 and the various circuits closed as indicated by the arrowhead, the motor should start and increase in speed. This will increase the voltage across the armature and strengthen the accelerating magnet, which will then draw in contact arms Nos. 1′ and 2′, as shown in Fig. 5. These two contacts cut out very nearly all the starting resistance, and the motor will then run at practically full speed with all the field windings in circuit. The direction of the current is the same in Fig. 5 as in Fig. 4, except that instead of the path of the armature current being from contacts 6 and 8 on the down-motion switch to R on the starting resistance, it takes the easier path from Y_3 down to the accelerating magnet, to contact point 2′ on the starting resistance, through the motor to the negative side of the line, as indicated by the arrowhead.

With contacts on No. 1′ and 2′ closed, the voltage across the armature is increased again, which increases the pull of the accelerating-magnet coil and causes contacts G_3 and H_4 to close, cutting out the remainder of the starting resistance and the series field winding in two steps. G_3 cuts out one-half the series field and the remainder of the starting resistance, and H_4 cuts out the last half of the series field, Fig. 6. This brings the motor up to full speed as a shunt machine. The direction of the current through the motor in Fig. 6 is the same as in Fig. 5, except that instead of passing through section 2-F of the starting resistance and the series-field winding, it flows from Y_3 connection to H_4 on the accelerating magnet, and then directly to the negative side of the line. The motor is now running as a shunt machine with the extra-shunt field at maximum strength. At starting, the armature starting resistance was not only in series with the armature, but also with the extra-shunt field. Therefore, by cutting out this resistance and series-field winding, the voltage is not only increased across the armature, but the extra-shunt-field current is also increased. Consequently, the increase in speed will not be so great as when this condition did not exist.

To increase the speed further, the operator places the car switch on point F_u, as shown in Fig. 7. This establishes a circuit from 4 to Y_3, through the fast-speed magnet coil to F' at the top of the control board, down to F_u contactor on stop-motion switch No. 1; from here to F_u on the car-operating switch, then to $-C$ on the safety switch in the car, around to $-O$ at the top of the control board, to the negative side of the line as indicated by the arrowheads. Energizing the fast-speed magnet coil will cause it to open contactor S and cut out the extra-shunt-field winding, as shown in the figure. When this field winding is cut out, the field strength of the motor is considerably decreased and the motor comes up to full speed.

Assuming that the car is about to reach the upper landing and the operator keeps the car-switch handle on the fast-speed contact F_u, in such a case the traveling limit nut on the drumshaft will come into action and turn cam No. 1 to the position shown in Fig. 8, thus opening the high-speed magnet-coil circuit, causing this field winding to be cut back into circuit and slow the machine down, as in Fig. 6. As the car about reaches the top landing, cam No. 2 of the stop-motion

switch opens contact U'. This breaks the circuit of the magnet coil of the up-motion switch, which drops out, breaking contacts 1 and 2, also 3, 9 and 4, and closes the bottom contacts 5 and 7, 6 and 8, as shown in Fig. 8. The opening of this switch opens the entire circuit of the motor and releases the brake shoes, which are set by the spiral springs.

When the up-motion switch opens and closes contacts 5 and 7, 6 and 8, they connect the armature through the resistance $E'I'$ and a dynamic-braking action takes place. As long as the armature continues to revolve and a field is maintained, a current will flow as indicated by the arrowheads in Fig. 8. This circuit is from the + brush on the armature to I on the control board to contact 8 on the up-motion switch, around to 6 and then to 1 on the down-motion switch, to I' on the stop resistance, through this resistance to E' back to contact 3 on the down-motion switch, to terminal E at the bottom of the control board and back to the negative side of the armature. This dynamic-braking action assists the mechanical brake to bring the car quickly and smoothly to a stop at the landing.

Should anything go wrong with the auxiliary circuit, the potential switch will open and contact arm x will close contacts y and z. This short-circuits the armature through the resistance r, causing a dynamic-braking action, since y and z are connected to the armature terminals, which will assist in stopping the machine.

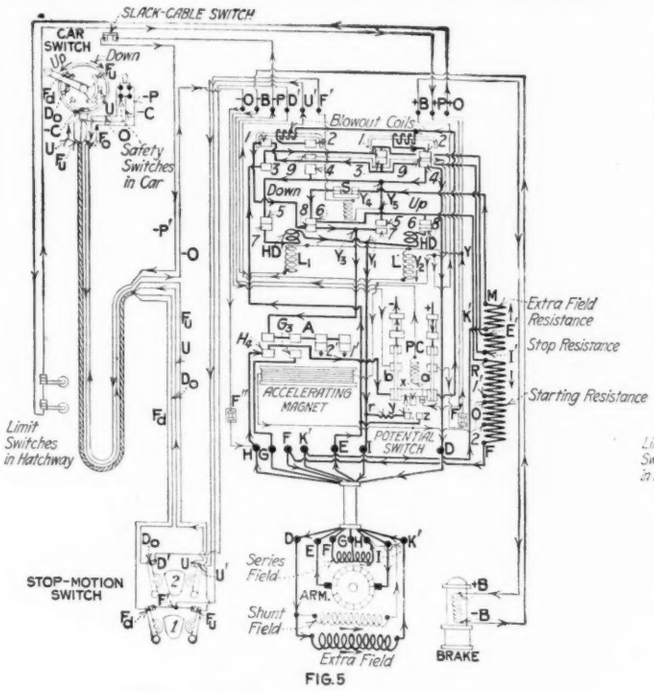


FIG. 5

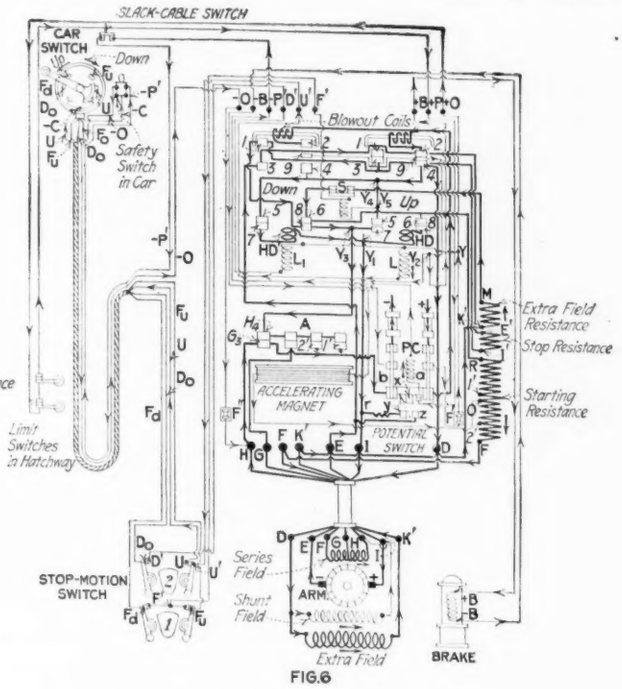


FIG. 6

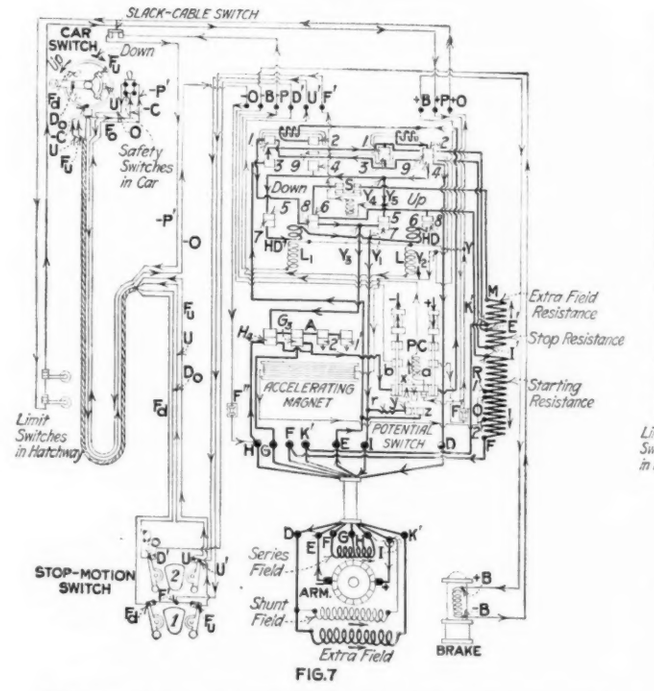


FIG. 7

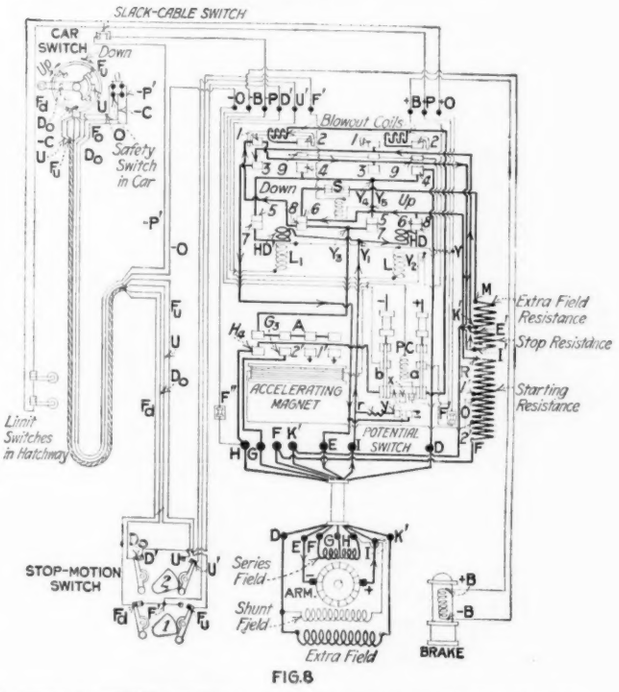


FIG. 8

FIGS. 5 TO 8. CIRCUITS ENERGIZED IN THE CONTROLLER, FIG. 1, WHEN THE MOTOR IS BEING ACCELERATED

Starting the Curtis Vertical Turbine

Gives directions, illustrated, for starting and putting on the line the Curtis vertical turbine.

THE vertical turbine was one of the most widely used of the older types of this class of prime mover, and a large number are still in service. It is assumed that the reader has a general knowledge of the construction of the machine, although it may be well to say that the generator and all rotating parts are held up by a step bearing, Fig. 1, to which oil is supplied at a pressure sufficient to hold up the rotor and all parts connected thereto. A double-acting duplex pump, usually steam-driven, pumps oil to the bearing. Sometimes an accumulator, a weighted cylinder movable on a plunger and connected into the oil line, is used to give a uniform pressure for the step bearing, just as it is used in hydraulic-elevator systems. In the oil-pressure line near the step bearing are a baffle and a screen. These must be clean so as not to impede the flow of oil. One form of this baffle is shown in Fig. 2.

Starting the Oil Pumps

There is always a gage provided on the gage board so that one can see when the oil is on. With only the one machine, it will be necessary to start the pump which supplies the oil, and is called the accumulator or step-bearing pump. After the oil is turned on, it is well to notice the pressure shown on the gage. If it is not as much as the pressure shown on the accumulator, there is no cause for alarm, for it is always less, there being a drop of pressure through the baffler. It would also be well to look where the oil returns from the step bearing, so as to be sure that the oil is flowing as it should. After a few starts one can tell by the action of the pump whether the proper quantity is going through. Next start the governor oil pump, which is used to supply the hydraulic gear which operates the steam-admission valves on the turbine and which supplies the middle and top bearings on the turbine shaft. The lower shaft bearings are usually lubricated by the same oil that supplies the step bearing. See that the oil is going through the bearings, which will be shown at the oil-return manifold provided for this purpose at a position convenient for the operator to see. Notice that the pressure remains constant, a gage being located near the manifold for this purpose; also notice that there is plenty of oil in the suction tank and that the surge tank has the proper quantity of air in it. The governor pressure carried on a 5000-kw. machine is 120 lb. The surge tank usually holds about 100 gal. and is cut in with the pressure side of the system and is charged with air to about half its volume; the connection between the tank and system is at the bottom, the tank standing on end, for the pump and system.

The air-charging valve should also be in the bottom of the tank. Charge the tank with an air pump, at the governor pressure, until there is the proper quantity of air. Means of shutting the tank off should be provided, so that after the pump is stopped at the end of a run, the air will not force the oil all out and get the air in the system.

Care should be exercised in charging this tank while running, for if enough air gets in it to drive all the oil out, some air may get into the hydraulic system

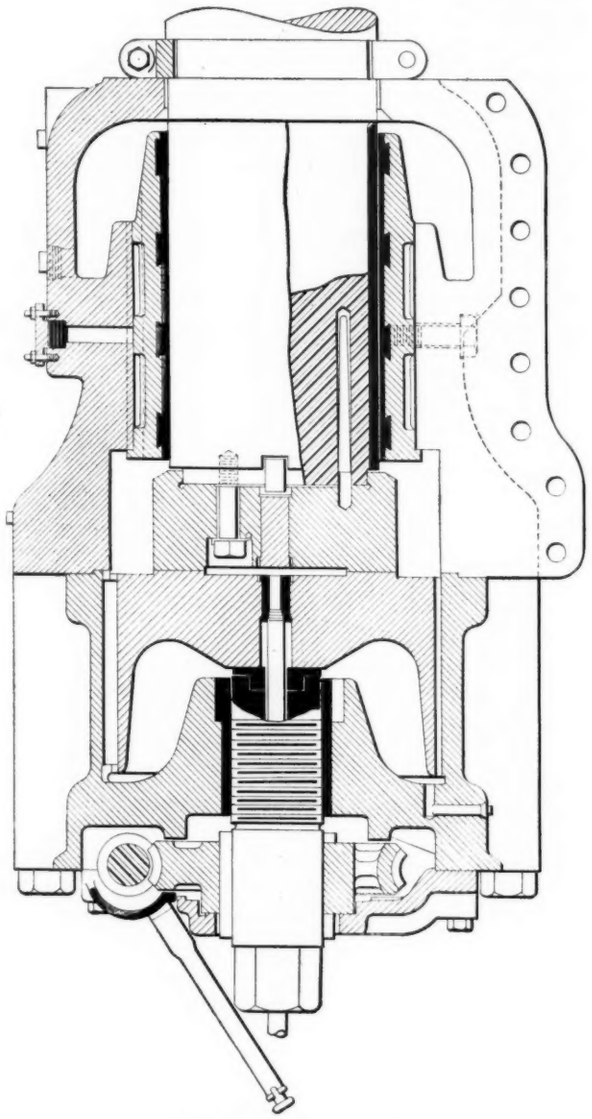


FIG. 1. STEP-BEARING, DOME IN BASE, OUTSIDE PACKED, ADJUSTING DEVICE FOR LARGE MACHINES

and the result would be a little exciting to say the least, as it usually does not require full pressure to operate this cylinder. But if some air under pressure should get in, even though the pilot valve was closed, it might move the piston full stroke and either shut or open all the admission valves to the turbine.

Open the valve to the shaft packing seal until the required pressure—about 5 lb.—is indicated on the gage, which is usually placed near the throttle valve. See that the atmospheric and all drip valves are closed, then start the air pump to form a vacuum in the exhaust-steam space of the condenser, then open the circulating-water priming valve. This will help to raise

the circulating water to the pump, before starting. When the circulating pump has "picked up" its water, close the priming valve and start the hotwell pump. See that the discharge valve from the pump is open. Now hook up the emergency governor, hook up the retaining latch by pulling down until in the position where the machine was stopped last (see Fig. 3). Open the throttle valve slowly and bring the turbine gradually up to speed. One should make sure that the speed indicator and governor are working properly before picking up the load, also that the automatic-stage release valves, Fig. 4, are working as the load comes on the machine. If the indicator rod *A*, Fig. 4, moves down as the stage pressure rises, the valve is working properly. The first-stage pressure is usually 30 to 60 lb. according to the load on the turbine. If anything should go wrong with the controlling governor and the turbine begins to race and the emergency governor does not trip the valve, raise up the trip handle *A*, Fig. 5. This trips the throttle valve by hand, cutting off steam and bringing the machine to rest. If the machine is lagging or the valve mechanism and governor is surging, the trouble will usually be found in the pilot valve *A* or piston rings *B*, Fig. 6. It is good practice to remove the pilot valve and wash

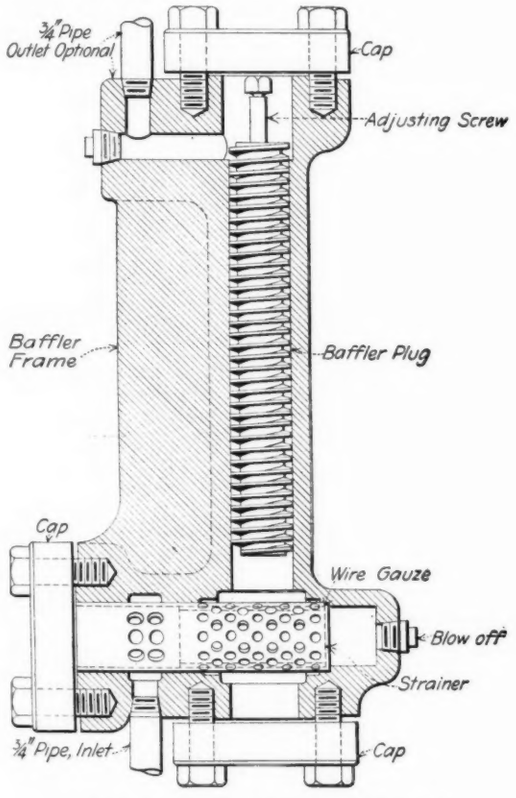


FIG. 2. STEP-BEARING BAFFLER

out the valve ports once a month. The piston *B*, Fig. 6, should be taken out of the hydraulic cylinder and examined once every six months and the piston rings carefully inspected and put in working order.

Sometimes, when at a little less than full speed, the machine will begin to rock or shake badly; this is the critical speed. As this is approached, it is well to give the machine a little extra steam to get it through this speed as soon as possible. As soon as this speed is passed, throttle down a bit and notice if the governor properly comes into action.

If the governor takes hold well and starts to close the valves, watch the valves close, as they depend on springs to close them and sometimes they stick open. While the cams roll around and the lifting gear drops, this does not necessarily indicate that the valve is closed. If the valves are all closing, the throttle may

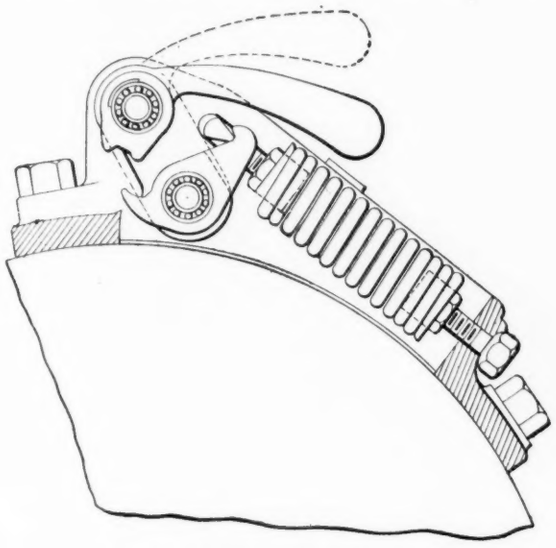


FIG. 3. EMERGENCY GOVERNOR

be opened up a little more until all valves except one are closed, and this one may be partly closed though admitting enough steam to run the machine at full speed. If, after opening the throttle more, the last valve closes, then throttle down again and see that all the valves are closed. If the machine still runs up to speed with the valves closed and the throttle open, it is evident that there are one or more leaky valves and that overspeed must be guarded against. The emergency trip is supposed to take care of that, but it also may be in bad order. These trips should be used frequently to keep them in good condition. As a general rule a machine should be tried each month for overspeed to see that the emergency trips when it should. It is best done by stationing a man at the throttle, one on top with a tachometer (indicating) and then have someone hold a valve or two open by means of a bar. Do not try to hold the pilot valve open, as some of the rods or levers may be sprung in doing so. Assuming that the machine comes up to speed, and the governor holds all right, signal the operator that the machine is ready to be cut in and at the same time open the throttle some more. The operator will do the synchronizing from the switchboard by means of the small motor mounted on the governor dome. This is controlled from the switchboard and controls the tension of the spring on the lever attached to the governor. This motor is also used to regulate the amount of load carried by the machine and is like those used on the reciprocating engines in alternating-current stations.

It should require about half an hour to load a machine to full capacity, although in case of emergency it can be done more quickly, but it is not best to do so. After the machine is cut in on the line, there

will be several things to do. First, in some machines there is a steam seal on the upper carbon packing; that is, it is simply a steam pipe usually ½-in., run between two of the rings of packing and acts like a water seal on some of the packing glands on centrifugal pumps. This is used when there is less than atmospheric pressure in the first stage, when, in case the packing was leaking, air would be drawn in at this point and lower the vacuum and put more work on the air pump. This steam seals the packing against such air leakage and is regulated like a water seal; that is, gives it enough to supply the leak, which can be judged by the surplus coming out of the packing, as in the case of a water seal. Where steam blows out of the packing and is not coming from the seal, which would be the case if the first-stage pressure was above atmospheric and the packing leaked, there is another pipe coming out of the packing case and between the rings. This is connected to one of the lower stages, or the condenser, and is used to draw the leakage away. This line has a valve in it and should be open only enough to take care of the leak, the amount being determined by the small amount of steam blowing out at the shaft, and shows that no air is being drawn up through the pipe.

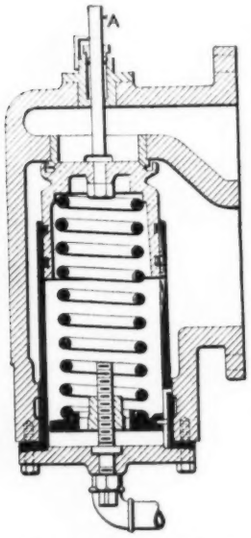


FIG. 4. AUTOMATIC STAGE VALVE

This seal and pipe are used to keep the steam out of the generator, and from heating the middle bearing. Some of the steam may get into the middle-bearing oil pan, there condensing and putting water into the oil system. The oil returning from the bearings should be noted both as to quantity and temperature, to see that the governor pressure is ample. Particular attention should be paid to the temperature so that a comparison may be made later to note the rise. There should be a cooling coil in the suction tank, and it should be noted that water is flowing through. There should also be some means of cooling the step-bearing oil.

The vacuum should be noted at this time, also the temperature of the condenser. If there is not enough circulating water, the temperature of the condenser will rise and the vacuum will fall. A thermometer should be placed in the suction of the wet vacuum pump, as frequent visits to this thermometer will enable the operator to keep the right amount of water going through the condensers to maintain the temperature consistent with the proper vacuum.

If the condenser is cold and the vacuum poor, there probably is a leak or the pump is running too slow or has bad valves. On the lower end of the shaft there is another set of carbon packing, which is steam-sealed. If the packing is leaking and the seal steam not on, the vacuum will be lowered. A pipe should be run out from the place where this seal is tapped in. discharging to the atmosphere. By keeping a little steam coming out of this pipe, it may be known that the seal has all the steam it can use. If unable to get any steam back from this vent, it is evident that the packing is leaking. If the steam flows out in too great a volume, some may be going to the step-oil discharge, which will heat the oil as well as get water in it. Gages on this vent line are usually of no value, as the pressure recorded is so slight that it cannot be measured on the ordinary gage, therefore a water tube, similar to a draft gage, is sometimes used; but after

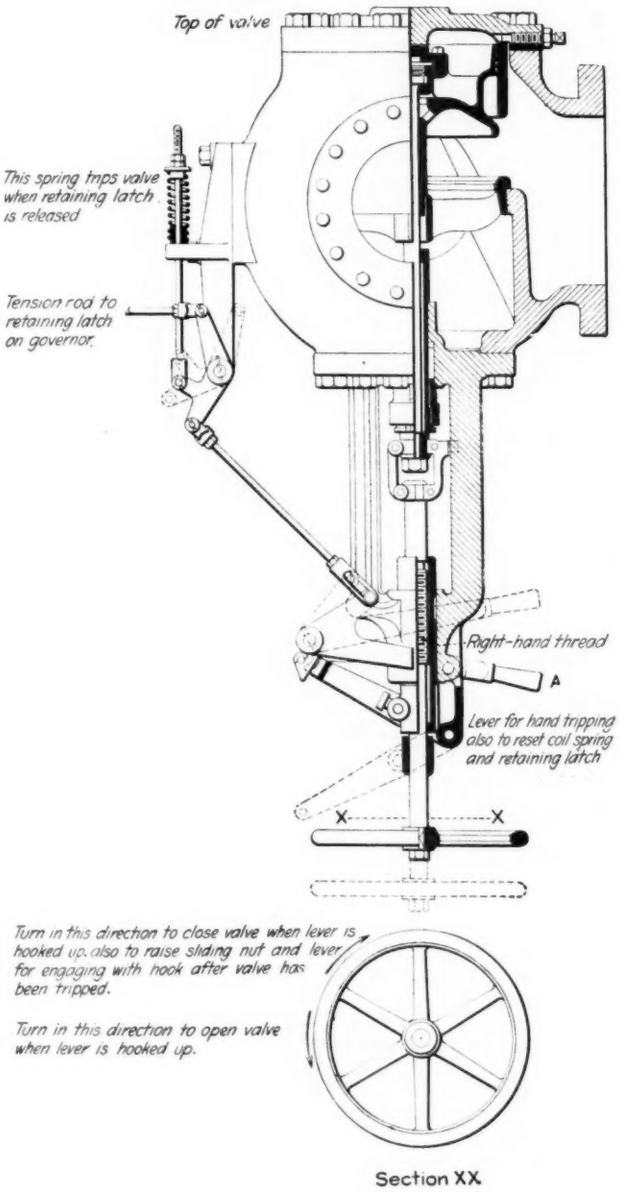

Top of valve
This spring trips valve when retaining latch is released
Tension rod to retaining latch on governor
Right-hand thread
A
Lever for hand tripping also to reset coil spring and retaining latch
X
X
Turn in this direction to close valve when lever is hooked up, also to raise sliding nut and lever for engaging with hook after valve has been tripped.
Turn in this direction to open valve when lever is hooked up.
Section XX

FIG. 5. BALANCED EMERGENCY TRIP AND THROTTLE VALVE (SCHUTTE AND KOERTING TYPE)

having filled it up, following each "blow out," several times a day, one will soon use the open vent. One-quarter inch is large enough for this pipe.

The wet-vacuum pump should be looked at again to see that it is taking care of all the condensate as fast as formed, which can be seen from a glass gage usually provided on each condenser. They are tapped into the shell or steam space and near the bottom and indicate the height of condensed steam in the shell.

This is important, for the air-pump suction is usually connected to the lower part of the shell to draw out the coolest and heaviest vapors. While the wet-air pump likely took care of all the condensate when starting up, it might not do so after a high vacuum is reached, owing to air leaks in the pump or in the suction to the pump. It is imperative that all joints be air-tight. By consulting a steam table and noting the relative volume of steam at atmospheric pressure and 29 in. vacuum, a good idea may be had of how a small leak in the vicinity of the wet-air pump will affect the flow of water to the pump. There is an equalizer line running from the air or suction chamber of the wet-air pump back to the condenser, usually a 1½-in. pipe, which is supposed to care for such conditions, but its capacity is limited.

After the operator has looked at the oil, wet-air pump, dry-air pump and vacuum gage, noted the temperature of the condenser and bearings, determined how the step pump is working, that the accumulator is not stuck, noted the load on the machine by seeing how many valves are open, he will take a long breath and get ready for another round of inspection.

If the load has been thrown on too suddenly, the machine may vibrate badly. By decreasing the load and warming up more gradually, it will cease soon if too rapid heating is the cause of the vibration. The upper carbon packing should be looked at again, for if the stage pressure is above atmospheric the steam seal is unnecessary and it may not require the valve open between the upper rings and the lower stage, because sometimes packing that leaks while cold, will not leak after heating.

Some Things To Observe

See that the hydraulic gear responds promptly to the pilot valve, also that the pilot valve is working freely, as it requires but a very small piece of packing or waste to hold it fast. The ball-bearing top on the governor should be examined soon after starting. It should be oiled frequently with clean oil. Notice the surge tank again, to ascertain if air pressure is not being lost, if the pumps fail, for this is the reserve until started again. The step-bearing suction tank should be observed for temperature and quantity of oil or water, whichever is used. The maximum temperature in the summer should not be over 180 deg. F. and somewhat cooler in the winter, the temperature being taken at the return from the step bearing. The temperature at the middle and top bearings should not go over 170 deg. and 150 deg. F. respectively; the middle one will of course be the warmest owing to the proximity of the steam. In fact, as one old engineer said, the big difference he saw between the reciprocating engine and turbine was that where he formerly put in the time packing glands and keying up the bearings and valve gear, he now put it in watching thermometers and gages. If everything seems to be working in fair condition around the machine, the engineer can take a look at the rest of the plant, but someone should always be left in charge of the turbine.

In shutting down one of these turbines first throw off the load, and if running in parallel with other machines, the load can be shifted by using the synchronizing motor on the governor or a hand-operated control. If the machine is running by itself, it will have to be throttled a little. If it be an alternator in parallel with others, the load cannot be changed with a rheostat as in direct-current work. After the load is worked down as low as it will go, trip the throttle. Then the switch is opened. It is bad practice to cut out with a full load, for obvious reasons. As soon as the throttle is closed, shut down the dry-air pump, then the wet-air pump, then the circulating pump. The steam seals may all be shut off now, and this will be all until the machine stops, which will be in about half an hour if

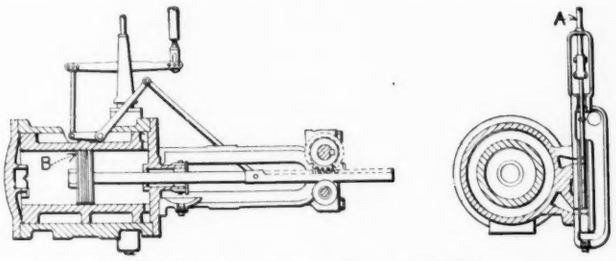


FIG. 6. HYDRAULIC CYLINDER AS EMPLOYED ON LARGE MACHINES

some field current is left on the generator, as is customary. If no field current is on, it may run four or five hours. As soon as the machine stops, the field should be opened; otherwise the machine will heat up, as the ventilation of these fields depend upon the fanning action of the rotor. Next shut the oil off the step bearing and stop the governor oil pump, being sure to shut the surge tank from the oil system, as otherwise the air pressure will force all the oil out through the middle of the top bearings and perhaps get some air into the system, thus requiring it to be worked out when started up again, as well as to charge the tank with air. These tanks should be connected with the system by a two-way cock, one side connecting the pressure side of the system to the tank, the other position of the valve connecting the tank to the suction tank, not the suction pipe of the pumps. If it is not possible to charge this tank as previously explained, owing to insufficient pressure, the two-way valve can be turned to the suction tank, the oil discharged and the tank filled with air at the available pressure and then cut in on the system. If this two-way cock was connected to the pump suction, some air would get into the pump when emptying the tank and be discharged into the system.

If one were to take charge of a turbine station that had been running regularly, he would have to depend on some of the men working there for his first steps in starting and stopping, and it is safe to assume that the regular operator can take care of the ordinary running of the machine and it is usually safe to trust him to do so. If one has had previous experience, he can trace the cause of trouble back and generally find out where it started.

On the other hand, if the machine is just being put in, the man who is going to run it can get quite a bit of knowledge by watching it go in, but it is well, just as soon as it is shut down, for him to try to get a line on the general condition of the machine and make any necessary adjustments before it is time to start up again.

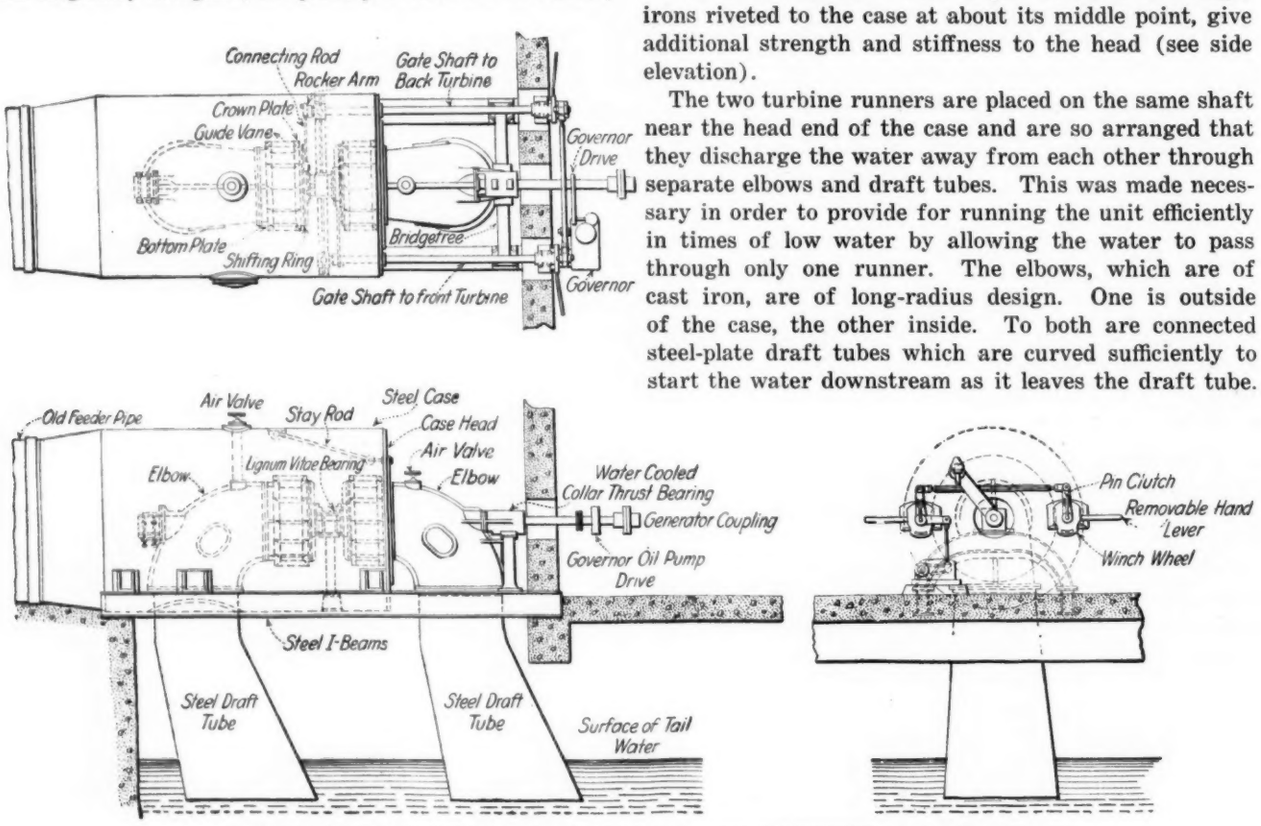
A Flexible Hydro-Electric Plant

BY CARL V. JOHNSON

A water turbine designed to obtain the maximum power out of the variable water supply. It has two runners in one casing, and either one or both can be used according to the stage of water. Either or both of the runners is under control of a single governor.

THE new water-turbine unit recently installed at the West Dummerston, Vt., plant of the Twin State Gas and Electric Co., which embodies the most up-to-date ideas in turbine design, makes this plant especially well suited to develop the maximum power from the available water supply.

The West Dummerston plant is situated on the West River about seven miles from Brattleboro. It was built in 1902 as an auxiliary to a steam plant in Brattleboro. As originally designed, the plant provided for two units, but only one, consisting of two pair tandem Victor wheels, direct-connected to a Stanley alternator, was installed. Flood conditions in 1915 so damaged the original plant that reconstruction became necessary. As the reconstructed plant was to be used in connection with the transmission system of the New England Power Co., it was redesigned to get the maximum power out of the variable water supply of West River. I. W. Jones, of Milton, N. H., was the designing engineer. The old unit was retained and a new one, built by the James Leffel & Co., and specially designed by this company to meet the conditions, was installed.



PLAN, SIDE AND END ELEVATION OF THE DOUBLE-RUNNER WATERWHEEL

The new unit consists of a pair of 30-in. Samson wheels in a steel case direct-connected to a generator. The turbine unit operating under a head of 23 ft. is guaranteed to give 450 hp. at a speed of 300 revolutions per minute.

The turbine case, which is 9 ft. diameter, is connected by means of a tapered section and butt-strap joint to the old feeder pipe, which was placed when the plant was first built. This feeder pipe is buried in the earthwork between the forebay and the power house. The new case is carried by means of cast-iron feet riveted to the steel shell on 15-in. I-beams placed in pairs running lengthwise on each side of the case. The cast-iron head riveted in the case was designed with an opening large enough to permit the removal of any of the inside parts. Four stay-rods, fastened by means of eye-bolts to the head and held with a pin between two angle irons riveted to the case at about its middle point, give additional strength and stiffness to the head (see side elevation).

The two turbine runners are placed on the same shaft near the head end of the case and are so arranged that they discharge the water away from each other through separate elbows and draft tubes. This was made necessary in order to provide for running the unit efficiently in times of low water by allowing the water to pass through only one runner. The elbows, which are of cast iron, are of long-radius design. One is outside of the case, the other inside. To both are connected steel-plate draft tubes which are curved sufficiently to start the water downstream as it leaves the draft tube. Each elbow is supplied at the top with a 4-in. valve which allows the admission of air to break the vacuum that would be formed in the draft tube when the water is shut off from the runner discharging into it.

The gate casings for this unit consist of cast-iron crown and bottom plates with large curves at their outer edges. Between the finished inside faces of these plates at the outside edges are fitted permanent wedge-shaped guide vanes which serve to direct the flow of the water and also to maintain the required distance

between the two plates. Wedge-shaped gates of the wicket type are pivoted on bolts inside of the permanent guide vanes. Each of these gate bolts may be removed separately without dismantling the rest of the gate casing. This allows the replacement of a gate, should it become broken, with the least amount of trouble. Locknuts on the crown plate prevent the loosening of the pivot bolts.

Split shifting rings which move on a neck of the crown plate connect by means of pins to short links which in turn are connected to the gates. The links ride on the top of the crown plate and are attached to the gates by means of pins extending through curved slots in the crown plate to allow for the swinging of the gate.

Gates Operate Separately

Two push-and-pull rods extend from each shifting ring to double rocker-arms on the gate shafts. Two gate shafts were provided in order that each set of gates might be operated separately. They are located on opposite sides of the turbine on a horizontal center line through the turbine shaft. These gate shafts, which extend through the head of the case, are carried in babbitted bearings near the rocker-arms inside of the case. The bearings are supported by brackets extending from the center bearing of the turbine shaft to the steel case. A separate foot riveted to the case allows the entire bracket to be dropped for removal.

The turbine shaft is carried by three bearings, two of which are inside the case (see plan and side elevation). These two bearings are lignum vitæ blocks. Both bearings provide adjustment upward and sideways by means of brass adjusting screws. The back bearing is carried directly on the elbow, while the center bearing is supported between the crown plates by means of a pedestal that extends to the bottom of the case. In order to provide as little interference as possible to the flow of the water, this pedestal is cylindrical in shape.

The third bearing, which is outside the case, is of the water-cooled, ring-oiling, collar type. Steel collars turned from the shaft take the end thrust, which is considerable when only one runner is operating, although it will be balanced when both are in action. Water is piped from the case head to the bearing to provide for cooling. This bearing is supported by a cast-iron bridge tree carried on the beams and is securely tied to the elbow.

Speed Regulation

The speed regulation of this unit is taken care of by an oil-pressure governor located in the generator room. Both gate shafts, as well as the turbine shaft, extend through openings in the wall into this room. In these openings are provided babbitted bearings for these shafts. Just outside the bearing and collaring against it is a winch wheel keyed to the shaft (see end elevation). This winch wheel allows for the operation of the gates by hand and also provides a means of locking the gates in any position. This is accomplished by having a stud in the base of the bearing project through a curved slot in the bottom part of the winch wheel. By tightening a nut on this stud the winch wheel, and therefore the gate shaft to which it is keyed, will be held in the desired position.

Riding loose on the extended hub of each winch wheel is a lever which may be locked to move with it by means of a pin engaging with a hole in the upper edge of the wheel on its vertical center line. The levers on each winch wheel extend vertically upward and are connected together at their outer ends by means of a long connecting-rod (see plan and end elevation) with forked end connections which are adjustable. One of the levers has another arm at right angles to the one just described, which connects by means of another connecting-rod to the governor (see left of end elevation). This arrangement makes it possible, by simply locking both levers to the winch wheels, to have the governor operate both gate shafts simultaneously or, by removing one pin, to have the governor operate only one. In the latter case the one not operated should be locked in the closed position by means of the stud and nut. By removing both pins, the governor may be cut out entirely so that both sets of gates may be operated by hand. The governor flyballs and the pump for maintaining the oil pressure are driven by belts from pulleys on the main turbine shaft.

This new unit, with its feature of separate operation of each set of gates, makes the plant especially well adapted to get the maximum power out of the available water supply. In times of extreme low water only one runner of the new unit will be supplied, which will develop up to 225 hp., using the water with high efficiency at the larger gate openings. At the next stage in the water supply, the old unit, which is rated at 350 hp., may be used. With a little more water the new unit, using both wheels, would be used to get 450 hp. The next combination would be the old unit with one runner of the new, which would provide 575 hp. Finally, with the maximum flow both units would be used, giving 800 hp. at full capacity. A study of the operating curves of both units would be necessary to determine just what combination would be most efficient for the available water, but it is evident that the new unit with its separate runner operation has provided a satisfactory way of getting power at the higher efficiencies, which come only when the turbines are operating at the larger gate openings.

When the total possible output of a plant can be utilized at all times in connection with an auxiliary steam-generating unit or other transmission system, this type of installation with such specially adapted machinery provides a very efficient hydro-electric plant.

Railroad Activities in War Preparation

As a result of coöperative activities, under the direction of the Railroads' War Board, the movement of thousands of carloads of lumber and other supplies to the cantonments has been accomplished practically without a hitch, and at the request of the Government, plans have been perfected whereby one million men are to be moved from nearly five thousand different points to the 32 training camps for the National Army and National Guard, by Oct. 20, carrying their tents and equipment with them. This means that in addition to the coaches and tourist sleepers occupied by them, more than 12,000 loaded freight cars must be transported.

The Electrical Study Course—Wheatstone Bridge

The fundamental principle and construction of the Wheatstone bridge are explained and problems worked out showing its application.

A PIECE of apparatus frequently employed for measuring electrical resistance is the Wheatstone bridge. This device is generally used to measure resistances above two or three ohms. The Wheatstone bridge consists of three known resistances R_1, R_2 and R_3, Fig. 1, arranged so that their values can be varied by removing different plugs. A galvanometer G and a battery B are connected as shown. The bridge is closed by the unknown resistance R, which is to be determined.

In measuring a resistance with the Wheatstone bridge the three arms R_3, R_2 and R_1 are so adjusted that points C and D, which the galvanometer connects to, are at the same potential. Under such a condition no current will flow through the galvanometer; consequently no deflection of the needle will be obtained—the bridge is then said to be balanced. How a condition like the foregoing can exist where no current will flow through the galvanometer will be better understood by considering Figs. 2 and 3. In Fig. 2 the galvanometer G is connected to the terminals of resistance R_3. The current will now flow through the galvanometer in the direction indicated by the arrowheads. If the galvanometer is connected to the terminals of resistance R_2, as in Fig. 3, the current will flow through the instrument in the opposite direction. In moving the galvanometer terminal from B to A the direction of the current has been reversed. Instead of transferring the galvanometer terminal directly from B to A, if the lead is connected into different points in resistances R_1 and R a location will be found where no current will flow through the galvanometer; this will be the point beyond which the current changes from one direction to another. At this point the voltage will be zero between the terminals of the galvanometer.

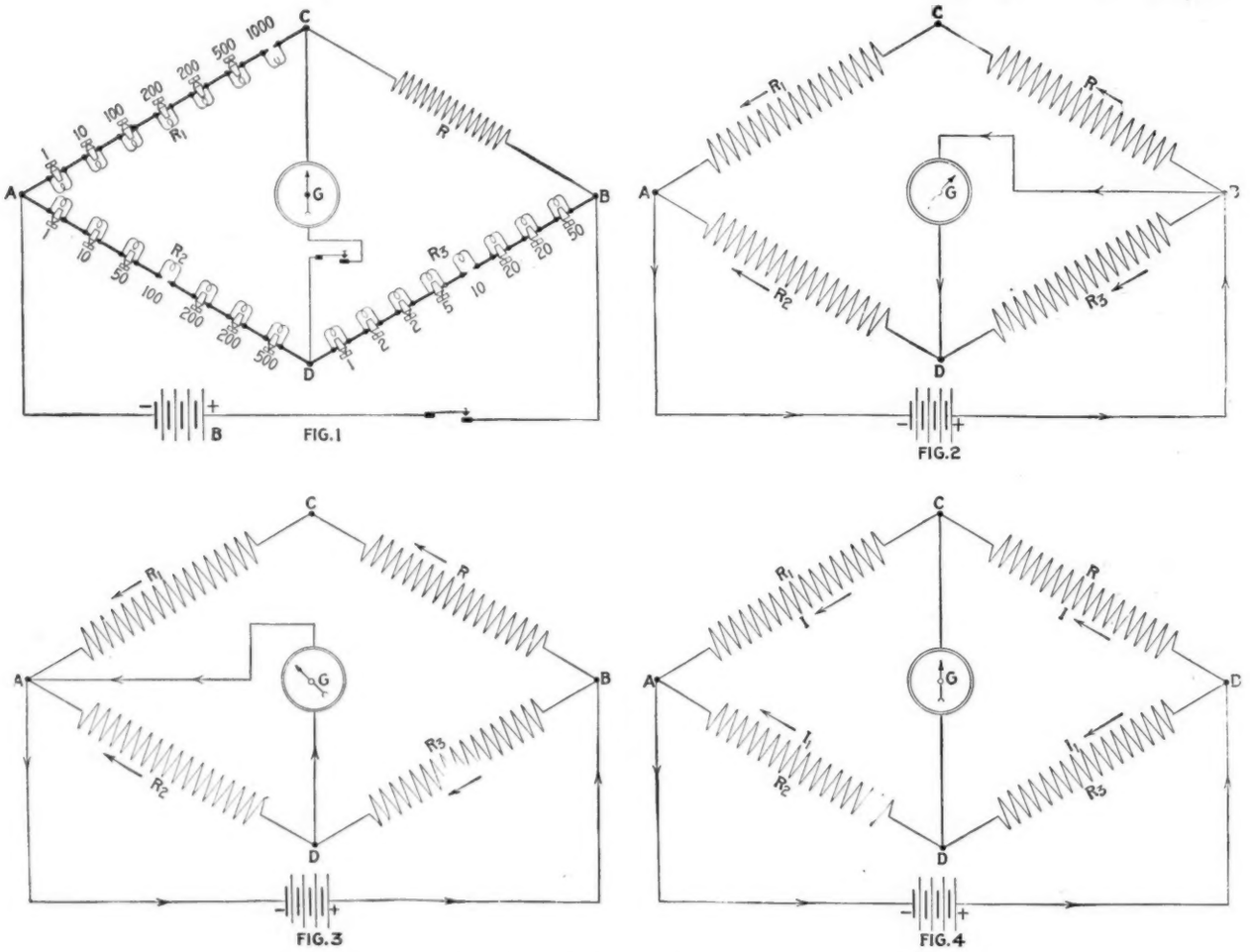


FIG. 1 FIG. 2 FIG. 3 FIG. 4

FIGS. 1 TO 4. SCHEMATIC DIAGRAMS OF THE WHEATSTONE BRIDGE

A hydraulic analogy of this condition is given in Fig. 5. Assume the two pipes 1 and 2 have a fluid flowing through them under pressure and that they are connected at the points A and B by small pipes. At A the pressure is shown to be 50 lb. in each at the points

where the pipes are connected. Since the pressure is the same at these points, no fluid will flow from one pipe to the other. However, at connection *B* the pressure in pipe 1 is 45 lb., and in pipe 2 it is 44 lb. Since the pressure is 1 lb. higher in 1 than it is in 2, a flow will take place from 1 to 2, as indicated by the arrow.

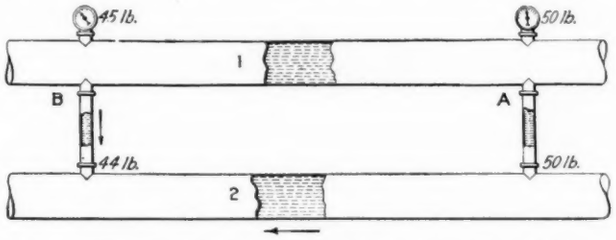


FIG. 5. HYDRAULIC ANALOGY OF BALANCED PRESSURES

This is just the condition that we have in a Wheatstone bridge when it is balanced; the points to which the galvanometer connects are at the same pressure and no current flows through the instrument. If the bridge is not balanced, the points to which the galvanometer connects are at a different potential and a current is caused to flow through the instrument, which will be indicated by the needle being deflected.

Condition to Give Balanced Pressure

In Fig. 4 consider the bridge balanced; that is, the voltage between points *C* and *D* is zero. In Fig. 5, in order that the pressure in the pipes shall be the same at point *B* it will be necessary to have the same drop in each pipe between *A* and *B;* that is, there is 5 lb. drop in No. 1, therefore there must be 5 lb. drop in No. 2 if no fluid is to flow from 1 to 2 at *B*. In the case shown in Fig. 4, there is 5 lb. drop in pipe 1 and 6 lb. in pipe 2; consequently fluid flows from 1 to 2.

In Fig. 4 as in Fig. 5, in order that no current shall flow through the galvanometer the volts drop from *B* to *C* must be equal to the volts drop from *B* to *D*. Therefore, the drop from *C* to *A* will equal that from *D* to *A*. The volts drop across any circuit is equal to the current, in amperes flowing in the circuit, times the resistance of the circuit. If we indicate the current in the two branches of the bridge, Fig. 4, by I and I_1, then the volts drop from *B* to *C* is equal to RI; from *B* to *D*,

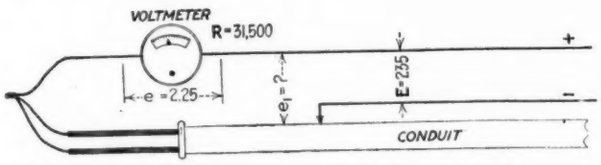


FIG. 6. CONNECTIONS FOR MEASURING INSULATION

R_3I_1; across *C* to *A*, R_1I; and from *D* to *A*, R_2I_1. We have already seen that the volts drop from *B* to *C* and *B* to *D* must be equal when the bridge is balanced; hence,

$$RI = R_2I_1 \qquad (1)$$

Also the volts drop from *C* to *A* and that from *D* to *A* are equal; therefore,

$$R_1I = R_2I_1 \qquad (2)$$

Before we go any farther with equations (1) and (2), let us consider a simple arithmetical expression that will help to show the reason for the final process in deriving the fundamental equation for the Wheatstone bridge. To illustrate:

$$3 \times 20 = 4 \times 15 \qquad (1)$$

and

$$3 \times 12 = 4 \times 9 \qquad (2)$$

Now if expression (1) is divided by (2), we have $\frac{3 \times 20}{3 \times 12} = \frac{4 \times 15}{4 \times 9}$. In this case the 3's and 4's cancel out and leave $\frac{20}{12} = \frac{15}{9}$, which in either case equals 1.66. Likewise, two equations may be divided one by the other to combine them into one. Dividing equation (1) by equation (2) for the Wheatstone bridge, we have $\frac{RI}{R_1I} = \frac{R_2I_1}{R_2I_1}$; I and I_1 cancel out of each side of the equation and the expression becomes $\frac{R}{R_1} = \frac{R_2}{R_2}$. Since R_1, R_2 and R_3 are known, being obtained from the bridge, Fig. 1, R may be found from the equation $R = \frac{R_1R_2}{R_2}$ $= \frac{1000 \times 10}{100} = 100$ ohms.

The correctness of the formula may be proved as follows: Assume the voltage of the battery to be $E =$

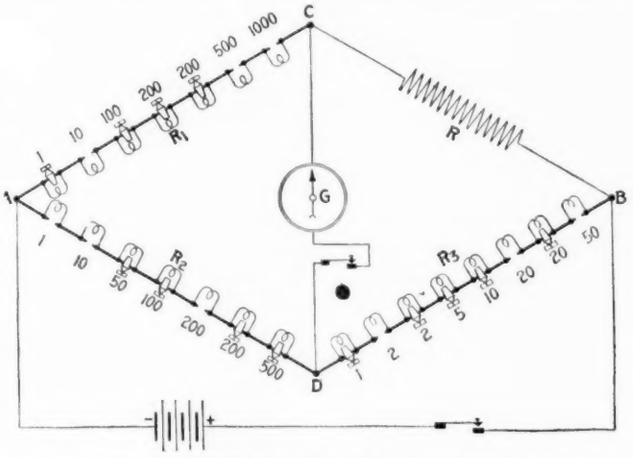


FIG. 7. WHEATSTONE BRIDGE DIAGRAM

5.5 volts. The resistance of path *BCA* through the bridge, Fig. 1, is $R + R_1 = 100 + 1000 = 1100$ ohms; and the resistance of path *BDA* is $R_3 + R_2 = 10 + 100 = 110$ ohms. The current flowing through path *BCA* is $I = \frac{E}{R + R_1} = \frac{5.5}{1100} = 0.005$ ampere, and through path *BDA* is $I_1 = \frac{E}{R_3 + R_2} = \frac{5.5}{110} = 0.05$ ampere. Then the volts drop across R equals $RI = 100 \times 0.005 = 0.5$ volt, and across R_3 equals $R_3I_1 = 10 \times 0.05 = 0.5$ volt. Hence it is seen that the volts drop from point *B* to *C* and the volts drop from *B* to *D* are equal. This conforms with the conclusion previously arrived at—when the bridge is balanced, $RI = R_2I_1$.

In measuring a resistance after an adjustment of the bridge has been made, close the battery key and then the galvanometer. Then if care is used in closing the galvanometer key, any heavy swings of the needle may be avoided if the adjustment of the bridge arms has thrown it considerably out of balance. See that the plugs are clean and do not handle them when oil or acid is on the hands.

When measuring a resistance, some idea can generally be gained as to what the approximate value is; adjust the bridge to this value and close the battery and then the galvanometer key. If this is too low, try a higher value; if this is too great, try a value between the two, until the bridge is approximately balanced. It is generally not possible to get an exact balance, but two values can be obtained, one giving a slight deflection of the needle in one direction and the other causing the needle to move slightly in the opposite direction, between the two deflections the correct value lies, which can be determined very closely.

The study problem, given in the previous lesson, is shown in Fig. 6; $e_1 = E - e = 235 - 2.25 = 232.75$ volts, and the insulation resistance $R_1 = \frac{Re_1}{e} = \frac{31{,}500 \times 232.75}{2.25} = 3{,}258{,}500$ ohms.

1. The load on a generator consists of fifty 25-watt, seventy-five 60-watt incandescent lamps, five 6.5 ampere arc lamps and two motors, one 5 hp. and the other 10 hp. The motors take 18 and 30 amperes respectively on a 225-volt circuit. The voltage of the lamp circuit is 112.5 volts. Find the total load in watts, kilowatts and electrical horsepower. If the load is constant for 3.5 hours, how much should a kilowatt-hour meter register if connected in the circuit during this period?

2. In Fig. 7 if the Wheatstone bridge is balanced under the conditions shown, find the value of the unknown resistance R.

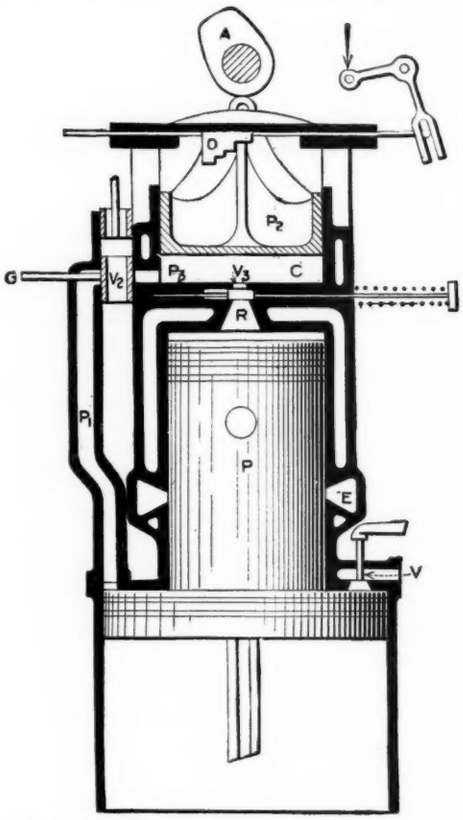
A New Design of Internal-Combustion Engine

BY M. FULTA

An internal-combustion engine has been invented in Japan by Y. Kinoshita, which acts on a new ignition principle designated by the inventor, "the spent-gas ignition method." This ignites the compressed gas mixture in the cylinder by the heat of the spent gas remaining in the cylinder, but at starting electric ignition must be used.

The sketch shows the construction of the engine. When the stepped piston P moves downward, air is drawn in through the valve V_1, and on the upward stroke V_1 is closed and the air is compressed in the pipe P_1, for the valve V_3 shuts the path between P_1 and P_2. When V_2 opens, the compressed air rushes into the combustion chamber C, lifting the other piston P_2 and also inducing the gas from the pipe G; hence the combustion chamber C will be filled with a mixture of gas and air. The valve V_3 closes the path between C and R, so that the spent gas is compressed in its cylinder by P to a very high temperature. Before P reaches the upper end of the stroke, V_3 opens and the mixture in C is ignited by the heat of the compressed spent gas. Then the piston P is driven down and power is transmitted to the crankshaft. Simultaneously with the uncovering of the exhaust port E, P_2 is forced downward by the cam A, driving out the remaining burnt gas through the port V_3, and P_2 and P complete their downward strokes when V_3 closes. The burnt gas remaining in R is compressed by P in its upward stroke. Thus one cycle is completed in two strokes.

When starting the engine, the crank must be set just to open the port V_3, so as to let the electric spark ignite the mixture compressed in C. After the engine starts, the electric device may be put out of action.



SECTION THROUGH NEW ENGINE, SHOWING UNUSUAL FEATURES

Governing is effected by means of the block O attached to a flyball governor. When this is pulled to the right, the lift of P_2 is reduced and the volume C decreased. At the same time the time of opening of V_1 is delayed and less air is drawn in through the passage P_1.

Taxation of Electric-Power Companies

A hydro-electric power company whose plant and water rights were situated in California, but the greater part of whose transmission lines were in Nevada, where most of the company's current was sold, was not subject to taxation in Nevada on the basis of valuation of transmission lines in that state as compared with the value of the lines in California, although California may have adopted the same basis in levying taxes in that state. Such a company may be taxed on its franchise value or its value as a going concern, if the value of the entire property, as determined by capitalizing its net earnings, exceeds the value of the company's constituent units. In determining what is a reasonable return on the property, courts should consider the hazards of the business, taxes, operating expenses and depreciation. (United States District Court, Southern District of Nevada; Nevada-California Power Co. vs. Hamilton; 240 Federal Reporter, 485.)

Editorials

The Engineer and the Union

WE print the following letter not because it represents our own views, but because it expresses the attitude of a large class of righteously dissatisfied toilers:

Editor of *Power:* I think your editorial on "Engineers' Compensation" very timely. Taking the plant I work in, rating 1100 horsepower, the engineers work twelve hours per day for twenty-five dollars a week, which is scarcely thirty cents an hour, the same wages laborers get in the shop for a fifty-five-hour week and time and a half for overtime; and this is much better than the average plant in Chicago outside those controlled by the International Union of Steam Engineers, where an eight-hour day prevails and fifty cents an hour, which I think is very reasonable. In fact, it seems to me we have tried out the "Learn More, Earn More" stunt until it has proved a complete failure, and the time has come, if we want to do our duty by our families as we have done by our employers in the past and take our place among upstanding men and fight for the helpless beings dependent on us, to do as other trades have and organize with the avowed object of getting better conditions and better wages. Let us get over the idea that we are something higher up the social scale than our fellow workers, for we are *not*, and those of us now who will sit supinely by and do not fight to get all they can for their dependents are slackers and cowards. Either let us join the present organization of stationary engineers or form a new one like the locomotive engineers. This at present would take too long to get results, and the only way, it seems to me, is to join solidly the International Union, and let us get at least as much as the common laborer and decent hours, for no man can stand twelve hours' steady strain without being the worse for it.

Hoping you will see this from my viewpoint,

Chicago, Ill. WILLIAM CHADDECK.

The man who is obliged to work twelve hours a day, seven days in a week for twenty-five dollars and support a family at the present outrageous prices of the necessities of life has cause for discontent.

When he sees the members of closely organized trades collect more money for less work, his natural impulse is toward an aggressive movement to improve his condition by collective demand.

The forcing up of wages in this way is a material present advantage to the members of the successful union; but is it sound economics? How much better off would the toiler be if everybody's wages were doubled?

The cost of producing things is made up of material, labor and overhead. Material is really materialized labor. One pays not for coal, but for the labor of getting it out of the ground and delivering it at his plant. When he buys flour, he is buying the labor of the farmhand, the miller, the transportation company, the distributor. If wages were doubled, the cost of material would be multiplied, the investment of the employer and hence the overhead would be increased, greater profits would be charged on these greater costs, and the toiler would find that his doubled wage would represent a less instead of a greater share of the wealth which he had produced, while capital would have collected twice the interest, and the manufacturer and merchant double the profit on the greater values involved.

The real engineer, the man who is capable of taking charge of a plant and getting the most out of it, who is a responsible department head directing the work of a staff of mechanicians, feels that he belongs to the executive rather than to the day-labor side of the business. It is to the man who aspires to a position of this kind that the motto, "Earn More, Learn More," applies, and though as a class such men are not overpaid, the individual and public recognition of their value is becoming more acute, and their position offers better opportunities for advancement through loyalty and accomplishment than through organized protest.

At this time, too, any dissension in the ranks of industry is as deplorable as would be dissension and lack of discipline in the ranks of the army, the success of which is dependent upon the loyal application and efficiency of the workers back home. Any attempt to create discontent and disturbance, to interrupt production and impair efficiency should not only be regarded with suspicion, but be treated as seditious. On the other hand, the Government should not desist in its purpose to choke the profiteer and insist that the army of workers upon which the world depends should be supplied with the necessities of life at the cost of producing them plus a fair profit. The government that has a right to take your boy and send him to the front has a right to take the coal baron's coal or the farmer's grain at a fair profit over the cost of producing it for your support and sustenance; and the government that has the right to impress men to fight against a common danger has the right to impress men to work that the efficiency of the fighter may not be impaired.

Standardizing Electric Motors

NO ONE question in the electrical industry today is attracting more attention than standardization. This is evidenced by the fact that at about every convention meeting of the various electrical societies the question is brought up in some form or other. The many advantages of standardization have long been realized by both the manufacturers and the users of electrical equipment. One of the serious problems in the adoption of standards in the past has been how to go about it and how far to go, because standards are rarely thought of until there is a multiplicity of devices for accomplishing the same end and none of them interchangeable. Then the big question is how to bring order out of chaos with the least expense and inconvenience to the user and the manufacturer.

At the eleventh annual convention of the Association of Iron and Steel Electrical Engineers two sessions were given over to the subject of standardization. One of the phases discussed was the standardization of electric motors, it being pointed out that a standard equipment allows the interchange of parts between the different machines and reduces the number of spare parts re-

quired. A standard equipment allows a manufacturer to carry this equipment in stock and reduces misunderstanding regarding the details of such an equipment. It enables an executive to delegate the choice of an equipment to a subordinate where the selection is limited to recognized standards. The work of the purchasing department is simplified, and the work of those who are concerned with the application of electrical equipment to various types of machine is expedited. It also tends to increase the number of research investigations to improve the standard equipment.

Although the foregoing advantages of standardizing electrical equipment must in most cases be admitted, and the standardizing of electric motors, controllers, cranes, etc., is the carrying out of the general idea of everyday standards, many of which we take for granted and which have existed for generations, nevertheless, it must also be admitted that there is a danger in carrying standardization to the point where it will tend to arrest rather than promote progress.

In reference to an electric motor it is possible, to good advantage to the industry, to standardize voltage, frequency, phases, capacities, speeds, torque, shaft dimensions, type of frame, etc., and probably some of the outside dimensions of the frame, such as spacing between the bolt holes in the base or the distance from the base to the center of the shaft—dimensions that may be easily controlled without interfering in any way with the electrical characteristics of the machine. This would seem to be the limit, because when we attempt to standardize the inside dimensions so that the parts of a machine of a given size and make may be utilized in another machine of the same size but different make, it would seem that the very element upon which future improvements in the art depends has been swept away. One feature that has not been taken advantage of to the extent that it should be by those interested in the application of electric motors is the arrangement of the drive so as to keep the number of different motor capacities to a minimum, thus reducing the spare parts or spare motors necessary to keep in stock. It would appear to be in this direction that the operating man should give his serious attention rather than to place restrictions upon the manufacturers, which may prevent development rather than accelerate it.

Technical Training

SOME years ago a noted plainsman of the Southwest, a resourceful, adventurous spirit, was speaking in depreciation of technical education. Time and money devoted to such training, he argued, might be expended to better purpose. The "school of hard knocks" was nature's polytechnic, and it alone could qualify a boy to meet successfully the duties and exigencies of life. When his companion ventured the opinion that while any man with tools and material and a modicum of native wit could build a shack that would answer very well as a protection against the elements, no one in his right mind would undertake elaborate plans and specifications for a modern skyscraper without first qualifying himself in a thoroughgoing way for that character of work. "W-e-l-l," said the old plainsman, "well, maybe not a skyscraper, but there is no sense in putting up such high buildings anyway."

If current reports be true, one of the disruptive forces in the new-blown democracy of Russia is just this lack of appreciation of technical knowledge. One of these reports is to the effect that the workmen in a certain establishment called on the engineers, demanding that since Russia was at last a free country and all citizens on a footing of equality, the engineers must take their turn in the mines and work like the rest. Then followed this colloquy:

The Engineers: "And who will do our work?"

The Workmen: "Some of us will take turns in your offices."

The Engineers: "But what will you do there?"

The Workmen: "The same as you do—sit around, sharpen pencils and smoke cigarettes."

The engineering knowledge of these workmen would be on a par perhaps with that of the layman who, visiting the shops of a gas-engine concern, wished to know what was done with all the gas manufactured by the engines. He took it for granted that since a coffee mill turned out coffee and a cider mill made cider and a brick machine made brick, a gas engine must make gas.

It was a proud boast, often heard in America in the years that are gone, that what one man could do could be done by another. A Yankee could turn his hand at anything. Happily, we have emancipated ourselves from this notion, always false but never so clearly recognized as false as in these days when it is the ideal that every turn of the hand shall conform to the dictates of science. Modern efficiency has little liking for Jack-of-all-trades.

The Typical American Way

THE new standard airplane motor is distinctively American in every way. That a couple of our foremost designers, assisted by numerous others in an advisory capacity, giving freely the results of their experience should be given, unreservedly, their choice in the use of any and all patented or proprietory designs is good American patriotism. That those two engineers should incorporate the chosen parts into a successful composite engine, and the Government have it made and tested in the almost incredibly short space of one month is truly American. That this engine is the lightest per horsepower and the "best ever" is notable. But that it is so standardized that unheard-of numbers can be produced in a short time and at low cost and small expenditure of labor is probably the most American feature of all. Parts may be made in any number of shops, brought together and assembled, while traveling the length of an endless chain conveyor, into a perfect engine ready for use, dispensing almost entirely with tedious hand fitting. This method of production is not practiced to any considerable extent elsewhere in the world and is as much in contrast with individual building as the factory way of making watches differs from the hand process.

From the short general description of this engine appearing elsewhere in this issue it will be seen that it is a thoroughly modern engineering product. It is to be hoped this example of the unselfish patriotism of business interests as well as individuals, will make possible the domination of the air which is believed to be perhaps the most effective means of winning the war.

Correspondence

Unaflow Engine Economy

I have followed with interest numerous articles in *Power* and other journals relative to uniflow engines of various types. The article on the Universal Unaflow engine economy, published on page 9 of the July 3 issue, is of particular interest, and a careful perusal of it brings up several questions which I find hard to answer from my own limited knowledge of the theory of this type of engine and the actual results being obtained with it.

The article is no doubt correct when it states that "superheat tends to correct the losses occasioned by improper cylinder design."

What then explains the fact that the curve in Fig. 1 of the article showing results with dry and saturated steam, is so much flatter than the curve shown in Fig. 3, taken from the same size engine under slightly higher steam pressure and with 102.5 deg. F. superheat? One would naturally suppose that the results would be directly opposite.

Another point: This particular type of engine uses a low percentage of clearance, made possible by the employment of auxiliary exhaust valves. At the lower loads, running noncondensing, the expansion line drops to atmospheric pressure before the central port opens. In view of this, what explains the claim that the use of the central port makes for low economy at low loads? There must be some logical answer to both of these questions, and I will appreciate comments relating to them.

E. HALL.

Buffalo, N. Y.

In reply to the questions asked by E. Hall concerning economy obtained on Universal Unaflow engines as set forth in the writer's article in July 3 issue of *Power*, I would state that superheat in the engine produces an economy curve which is parallel to the curve of the same engine when tested under saturated-steam conditions.

This is not true of the counterflow engine, as superheat in this type flattens the economy curve at under loads. Inasmuch as the economy curve of the Universal Unaflow engine is flat under saturated-steam conditions, it of course cannot be further flattened by the addition of superheat.

There are three reasons why the curve of superheat shown in Fig. 3 of the article referred to was not quite so flat as the saturated curves shown in Figs. 1 and 2.

First, it was a different engine, and second, it had not been run five hours when the test was conducted, the purchaser's engineer having arrived one day sooner than expected. Therefore the piston was not quite so tight as it would have been had it been given as long a run before the test as the engines whose results are given in Figs. 1 and 2. The engine was, therefore, not in as good condition for the test as it would have been had it been possible to operate it for a longer period. Whatever leakage there was would affect the economy at the light load to a greater extent than at the heavy loads.

Third, it is almost impossible to keep the superheat constant during a series of tests; and although the superheat averaged for the four tests 102.5 deg. F., it was 106 deg. at the test showing the economy of 15.55 lb., and for this reason another test was run at as nearly the same load as possible, with 100 deg. F. superheat, and a rate of 15.97 lb. was obtained. The full-load economy would have been better but for the fact that this test was run with only 95 deg. F. superheat.

Mr. Hall should not lose sight of the fact that aside from the light-load results which have just been explained, the curve of superheat paralleled the curve of the saturated tests on the other engine within a few tenths of a pound.

Regarding Mr. Hall's second question, it should be stated that it is only on the very lightest loads, approximating friction load, that the exhaust line drops to atmospheric pressure before the central exhaust ports are opened, but even in this event the engine is not counterflow by any means. The heads are steam-heated, and no exhaust steam is being washed across the hot heads or the cylinder walls that have contained the steam at boiler pressure and temperature, as is done in counterflow engines. Therefore, when steam is admitted on the next stroke, it finds the cylinder head and walls as hot as the admitted steam and consequently very little condensation occurs, even at light loads; whereas the condensation in counterflow engines at light loads is terrific.

A. D. SKINNER.

Erie, Penn.

Locomotive Efficiency

Under the caption "The Locomotive as a Crime," the *Literary Digest* in its issue of June 16, quotes part of an article that appeared in *Power*, May 22, over the signature of George H. Gibson. To anyone familiar with the modern locomotive, the criticisms will be recognized as entirely unfounded; but the prominence that has been given his statement by reputable journals may confuse the nontechnical reader. Therefore, refutation is demanded.

The renaissance in this branch of engineering might, with reason, be said to have begun with the establishment of the testing laboratory at Purdue University in 1891, where, under the direction of Dr. W. F. M. Goss, a remarkable series of tests were instituted on a full-sized locomotive. Prior to this time locomotive design had been along more or less empirical lines; but the Purdue tests laid the foundation of the science of locomotive design, and as a result improvements began to be incorporated in American locomotive practice. Another quite important contribution to this science was

made at the St. Louis Exposition in 1904, where, through the generosity of the Pennsylvania Railroad Co., there was assembled as a part of its exhibit a complete testing plant with a well-trained corps of operators working under the supervision of an advisory committee representing the American railroad and locomotive builders. In this plant eight of the largest and most modern freight and passenger locomotives were given an exhaustive test. Never before had it been possible to test locomotives of this power in a stationary plant under ideal conditions, so that the information obtained was of incalculable value; and it was made freely available by the Pennsylvania Railroad Co. as a contribution to the science of locomotive engineering.

This railroad still maintains at Altoona an elaborate locomotive-testing plant, and the results of tests are widely published in technical journals and are otherwise available to the engineering world. It would be easy to furnish a list of other railroads conducting systematic efficiency tests of their locomotives, but enough has been said to refute the statement by Mr. Gibson that "superintendents of motive power and master mechanics are too fully occupied by routine duties to take up research" work. It must therefore be evident that locomotives are not designed by "rule of thumb," but that the art is fully abreast of any other branch of engineering.

Locomotive Boiler and Furnace Claimed Not Inefficient

Reviewing more specifically Mr. Gibson's criticisms, one notes that he holds up as a horrible example of inefficiency the locomotive boiler and furnace—this, he says, is "most wasteful" and "fails to meet the requirements of business." If this is true, a comparison of the locomotive boiler and furnace with that of the stationary plant—with which we assume Mr. Gibson is familiar—should demonstrate this inefficiency. For this purpose, we have selected as an example of the modern locomotive the Pennsylvania Railroad Co.'s Class K4s, a high-speed passenger engine of the Pacific type which has been given an exhaustive test, the result of which is available for verification. For the stationary boiler and furnace, we have selected test data taken from *Trans.* A. S. M. E., Vol. 33, of a high-power water-tube boiler. This test is referred to in Marks' "Mechanical Engineers' Handbook."

The boilers were large and the furnace especially designed. Following are the data from these tests tabulated for easy comparison:

	Locomotive Class K4s,	Stationary Boiler and Furnace,
Date of test	May, 1915	May, 1911
Test No	4054	1
Boiler hp. developed	2,534	2,491
Heating surface, sq.ft	5,207	23,654
Effective grate surface	69.2	446
Fuel consumption per sq.ft. grate per hr	173	16.7
Sq.ft. heating surface per boiler hp	2.05	9.5
Eq. evaporation per hour, lb	87,414	85,948
Eq. evaporation per sq.ft. heating surface per hr	16.8	3.63

In other words, a stationary plant having about four and one-half times as much heating surface and about six and one-half times as much grate surface as the locomotive evaporated less water, and each square foot of heating surface in the locomotive evaporated about four and one-half times as much water as the stationary boiler.

The stationary plant was working at 105 per cent. capacity against 485 per cent. capacity for the locomotive. From tests when working at 200 per cent. overload, the locomotive has shown a boiler and furnace efficiency of 76 per cent. The average stationary plant working at an equal overload when equipped with all the fuel-saving devices proposed for the locomotive, by Mr. Gibson, will show only about 73 per cent. efficiency. Such a comparison gives some idea of the problems confronting the locomotive designer and how well he has solved them even when the entire power plant is in a space approximately $10\frac{1}{2}$ x 50 ft.; whereas, the boilers alone of an equivalent stationary plant will occupy a space approximately 20 x 90 ft. One must further consider that this immense power output must be developed while the power plant is moving on a base $56\frac{1}{2}$ in. wide at a speed of 20 to 90 miles per hour.

Mechanical Stokers Replace Firemen

Mr. Gibson states that "some roads are experimenting with mechanical stokers" to replace the human fireman. He should have known that these experiments began about 15 years ago and that today there are approximately 2000 locomotives on American roads so equipped. In fact, it is impossible to operate the monster locomotives of today to anything like their capacity by hand-firing. Experiments have been under way for two or three years looking to the substitution of mechanical draft for the exhaust jet, but so far the results have not been entirely satisfactory. Reliable estimates of cost of operation made by the builders of this type of equipment place it far above the figures given by Mr. Gibson. Nevertheless, the railroads are continuing experiments along this line as well as toward the diminution of the cinder loss, and as soon as something practical is evolved it is sure to meet with general acceptance. It might be well here to call attention to a curious misstatement by Mr. Gibson, that the draft in the firebox of a locomotive amounts to as much as 10 in. of water. The maximum draft in the firebox recorded in the Pennsylvania tests when burning 190 lb. coal per square foot of grate is 3.8 in. of water. Under average conditions, the firebox vacuum rarely exceeds 1 in. of water.

The fact that the locomotive is a moving power plant with relatively high cost of maintenance, also that chances of failure must be reduced to a minimum, has operated to keep the design as simple as possible. In other words, any device that bids for acceptance by the railroads must show a relatively high economy to offset its natural increase in cost of upkeep; it must also be reduced to its simplest terms to insure against failure in service. This fact has operated to restrict the use of such devices as feed-water heaters and economizers. Nevertheless, several American roads are now testing out experimental heaters, and with the rising cost of fuel it will probably be but a short time before they will become part of the standard equipment of the modern locomotive.

Perhaps the most remarkable inference to be drawn from Mr. Gibson's article is his lack of information with regard to the status of the locomotive superheater.

From his statement one would assume that the locomotive designer is, as yet, ignorant of the economies obtainable from this device. It may surprise him to learn that there are today over 22,000 locomotives equipped with superheaters, nearly 6000 having been applied in the year 1916. This fact would seem to indicate that the responsible mechanical officers of the American railroads are not slow to adopt meritorious devices.

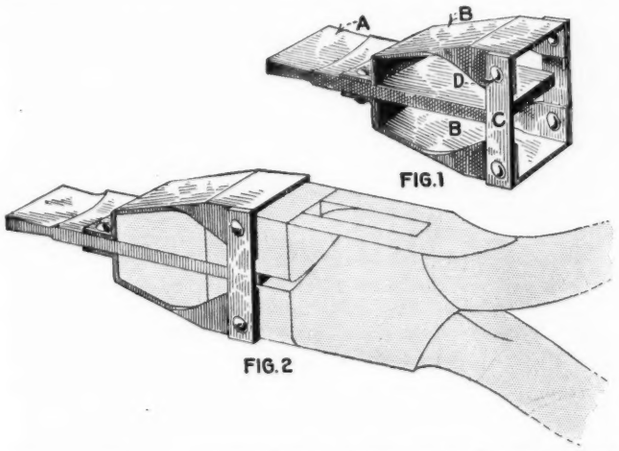
Far from being a "crime against civilization," the American locomotive can challenge comparison with the product of any other branch of engineering; and it is constantly being improved both in capacity and economy, but its sponsors do not claim that it has yet reached the summit of perfection. The most radical changes in design are resorted to when necessary to meet new operating conditions, but changes are not made unnecessarily, and any suggested improvement must meet the acid test of efficiency. The development of the American locomotive is an interesting and instructive field for investigation, and it would doubtless repay anyone interested to take the necessary trouble to post himself on it.

H. S. VINCENT,
New York, N. Y. American Locomotive Co.

Screwdriver Attachment for Use on Cutting Pliers

Since pliers and screwdrivers are the tools most frequently used by the electrician, they should be in such a form that they can be easily carried around. Pliers with a screwdriver forged at the end of one of the handles are common, but the screwdriver is unhandy and is seldom used.

After considerable experimenting, the screwdriver attachment shown in the illustrations was developed and



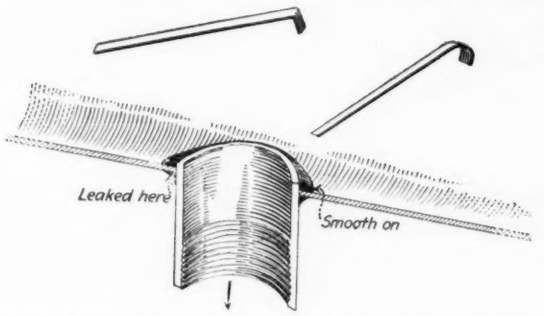
FIGS. 1 AND 2. SCREWDRIVER ATTACHMENT FOR PLIERS

has proved very useful to me and to other workers who have made one. In Fig. 1, *A* is made of tool-steel and hardened. The jaws *B* are bent from $\frac{1}{16}$-in soft sheet iron and held together by the two straps *C* and rivets *D*. Dimensions cannot be given, as curves and shapes change in accordance with the shape of the pliers used. The form is obtained by bending the sheet iron around the pliers and riveting it to the tool-steel blade *A*. The device is so small that it can be easily carried in the vest pocket. Fig. 2 shows the screwdriver attachment in place ready for use.

M. P. BERTRANDE.
Ozone Park, L. I.

Large Repair Bill Saved

The main steam header in our plant had drain connections made by brazing sockets to the under side of the header, and recently one of these sprung a leak. The drip line extended along between two channel-iron beams which supported the 12-in. header so that rebrazing would necessitate taking one whole length of 12-in. pipe



LEAK AROUND SOCKET STOPPED WITH IRON CEMENT

to the shop. Before undertaking this expensive and laborious job, it was decided to try the following experiment, which proved a success. A 5-lb. can of Smooth-On iron cement was secured and applied with the special tools shown in the illustration. Some condemn iron cement because it will not achieve the impossible, but if applied in the right way, as in this case on the inside, it will do good work.

Philadelphia, Penn. EDWARD T. BINNS.

The Coal Problem in Argentina

Scarcely had the Europeon War broken out ere the trouble with this country's coal supply became evident. First we had increased prices; next came the Government restriction and ultimately the almost impossible task of obtaining any coal at all. For some time there was the alternative of importing American coal, but with the entry of the United States comes danger of further limitations. Chilean coal is suitable to certain uses only, and trial alone will show just how far the fuel from the neighboring republic will serve our needs. Meanwhile, it is very evident that the Argentine Government will do well to safeguard itself by investigating the local coal fields. It is known that in Mendoza and in Neuquen there are coal deposits, although, through lack of capital, nothing as yet has been done to carry out a scientific investigation into the value of these resources, much less to make use of them on any extended scale. Admittedly the question of transport and the absence of regular communication are serious drawbacks, especially considering the state of the national finances.

It is understood here that the United States can supply coal, provided the ships are sent to transport it, confronting the Argentine Government with the task of finding ships, as this country has, to all intents and purposes, no ships for the trade. American ships are of course to be used for service connected with the war first to supply essential articles to the Allies. Nevertheless, it is hoped that some plan may be found whereby a certain number of ships may be retained in

the Argentine trade, quite a reasonable supposition in view of the close ties and growth in commercial dealings between the two republics. Something must also be done by Aregentina at once, seeing that the national transports are manifestly insufficient to handle the trade.

The scarcity of coal caused the introduction of wood in the power houses and the once deep-black stack-top smoke has changed to a whitish gray. A large power house in the South Docks, a German firm, has four large stacks; and as the supply of coal gradually diminished, the stacks one by one ceased to pour forth black smoke. It was then that Quebracho Colorado, a wood obtained from Santa Fe, Santiago del Estero and the Chaco, was introduced. The Quebracho is a hardwood and is good fuel, but the process of handling wood is by no means as convenient as that for coal. Automatic stokers became useless. The once rapid grab bucket and derrick that dumped the coal hung lazily over the desolate yards. The introduction of wood had changed the routine of work to such a degree that an entirely new system had to be installed to cope with the fuel problem.

One day there appeared in port two cargoes of coal. One vessel came in and docked; the other stayed out in the roads. Their destination was Buenos Aires and the consignee the Electricidad Transatlántico. The captains, upon discovering that the coal they carried was destined for a German firm, refused to deliver it. To make matters worse, some demanded the seizure of the coal, the vessel in the roads refusing to come in and dock. To the reader, the effect the closing down of a large power house would have in the community is evident. The case ended abruptly when the Government took a hand in the affair and demanded that the coal be delivered to the consignee. In the last 10 months in all my travels about the country I have seen few locomotives that were not burning wood.

Buenos Aires, Argentina, S. A. W. G. SCHMIDT.

Adjusting the End Play Stopped the Sparking of Brushes

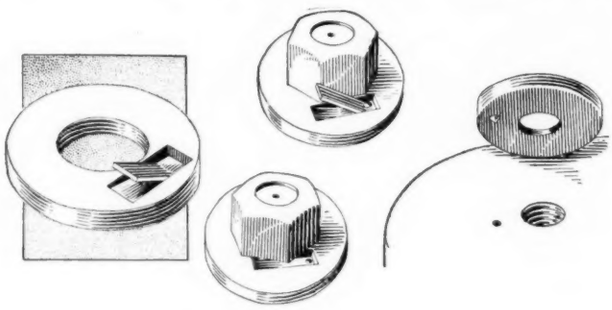
Having read with a great deal of interest the troubles that *Power* readers have had from sparking at brushes, I have come to the conclusion that the remedy for one case will not effect a cure in another. Upon taking charge of a plant some time ago, one of my first troubles was caused by badly sparking brushes on an exciter. The sparking would heat the commutator until the solder on the bars melted and the rest of the machine got very hot. The other employees around the plant seemed to take the sparking as an everyday affair and informed me that it could not be remedied, as everyone else who had had charge of the plant had fallen down on this feature, as well as several outsiders who had been called in, and that there was no use in fooling with it.

I took the armature and turned the commutator down and, after carefully balancing, replaced it in the machine. I then obtained new brushes, spaced them correctly and started up. In a few hours the machine was sparking again and soon was as bad as ever. It was not overloaded and the mica was not high, but in spite of all efforts the brushes would have to be lifted after the day's run and the commutator cleaned. Every kind of brush lubricant that I ever heard of was used, but it did not help any. One day, after having the armature out and replacing it, no end play was allowed; since that time (over three months) the exciter has not given any trouble and not a spark can be seen.

Braemar, Tenn. J. W. STANLEY.

A Successful Lock Washer

I have seen many devices for holding a nut or capscrew in place, but most of them have their objections. The illustration shows a washer that I have made and used with success after several other devices had been tried, to hold a capscrew in a bearing cap on a vertical shaft. Although it is quite tedious to make without



NUT OR CAPSCREW LOCK WASHER

proper facilities, I believe the washer could be made in one operation with a suitably designed die or punch. As shown, a small spring-steel catch is riveted in a recess in the washer and projects above the surface when not depressed, which is done when the nut is removed. The under head of the rivet is cone-shaped, to be fitted into a suitable recess in the casting of the machine, made with center punch or with a small drill. If offered at a reasonable price, I think this lock would find a ready market. T. O. VICKERS.

Trenton, N. J.

Service in the Merchant Marine

Judging from the letter by Austen Bolam on page 191, in the issue of Aug. 7, wherein he declares that the inducements offered by the United States Shipping Board to engineers are not "good enough," one would be inclined to think he was a little shy of salt water or was looking for something extremely good.

The Shipping Board now offers to land engineers opportunities that were never before extended on such liberal terms, and that will never be again after the present emergency is past, it is safe to predict. Life aboard ship is vastly different from what it was in the olden times when ice machines and electric apparatus were unknown, to say nothing of the laws now requiring that even the denizens of the "forepeak" be supplied with clean bed linen and the best of "eats," and last but not least, the highest wages paid by any nation for the class of men Uncle Sam now wants. A little patriotism coupled with the inducements offered, should be sufficient to bring out enough good men to meet the need. Surely the game is worth the candle.

Mount Tom, Mass. H. A. LIVINGSTON.

Inquiries of General Interest

Reducing Size of Pump Suction—Under what conditions may the suction pipe of a pump be smaller than the inlet provided by the maker of the pump? R. W.

Where the suction is supplied under pressure and the pump is to be used below its capacity, the suction-pipe size may be reduced accordingly, provided the required velocity of the suction water would not be more than about 3 ft. per second.

Charge for Ammonia Refrigerating System—How may it be known what amount of ammonia charge should be supplied to an ammonia refrigeration system? L. G.

The amount of the charge will depend in any case on the cubical content of the piping system and the pressures for which the plant is designed. The ammonia is to be charged gradually and stopped when the proper working pressures are obtained, when operating under normal conditions. Too low a head pressure is an indication that the charge is too small.

Relative Effectiveness of Vertical and Horizontal Coils—Which is more effective as heating surface for warming a room, vertical or horizontal pipe coils? J. M.

Vertical pipes are less effective heating surfaces because the air, heated immediately in contact with the lower portions of the pipe, rises more uniformly along the pipe surface and offers greater hindrance to convection of heat to the surrounding atmosphere. For this reason short vertical-type radiators are more effective per square foot of radiation than higher radiators and the lower pipes of horizontal pipe coils are more effective than the upper pipes.

Allowance for Relief of Load on Girth Seams—What allowance is made for the relief of load on the girth seam of a boiler by tubes or stays? D. T.

The A. S. M. E. Boiler Code provides that when 50 per cent. or more of the load which would act on an unstayed solid head of the same diameter as the shell is relieved by the effect of tubes or through stays, in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent. that of the longitudinal joints.

Overheating Clean Boilers Without Forcing—What causes clean boiler-heating surfaces to become burned without forcing the boiler? R. G.

The boiler-heating surfaces may become overheated when circulation of the water is not rapid enough to sweep the steam bubbles from the hot surfaces or when from any cause the steam bubbles either pocket or adhere to the heating surfaces where they are formed. Under such conditions, just as when the boiler surfaces are covered with a nonconducting scale, the heat of the fire is not promptly transmitted to the water of the boiler and the boiler material becomes burned.

Piston and Pump Displacement—What is meant by piston displacement and pump displacement, and how are they measured? W. L. B.

Piston displacement is the volume swept through by one stroke of a piston and is the net projected area of the piston times the length of stroke, expressed in cubic feet or in cubic inches. The displacement of piston and plunger pumps is commonly expressed in gallons, and refers to the number of gallons of water that would be discharged in one stroke without slippage of the pump. For a piston pump, the displacement in gallons would be the net projected area of the water piston in square inches × stroke in inches ÷ 231. For a plunger pump the displacement would be the cross-sectional area of the plunger in square inches × stroke in inches ÷ 231.

Distribution of Scale Affected by Location of Feed—Two horizontal return-tubular boilers each 72 in. diameter by 18 ft. long are operated in battery along with another boiler of the same type 60 in. diameter by 16 ft. long, and all the boilers are supplied with feed water from the same open feed-water heater. The 72-in. boilers are provided with chain-grate stokers and have feed connections that extend 18 in. through the front heads. These boilers are badly scaled, while the 60-in. boiler, which is hand-fired and forced harder than the others, is fed through the bottom blowoff, but shows little or no scaling. Would the difference in feed connections account for the difference in scaling? R. C.

The difference in location of the feed connections would have an effect on the character of the circulation of the water in the boilers and make a difference in the location of scale deposits. In the case of the 60-in. boiler, the deposits of sediment and scaling material may be more favorably distributed for discharging them when blowing down the boiler by the bottom blowoff.

Allowable Working Pressure for Flat Stayed Surface—What would be the allowable working pressure for a flat surface of a boiler made of ½-in. steel plate of 55,000 lb. T. S. where the plate is supported by screwed and riveted stay-bolts pitched 8 in. by 8 in.? A. S.

The maximum allowable working pressure is given by the formula,

$$P = C \times \frac{t^2}{p^2}$$

where

P = Maximum allowable working pressure, lb. per sq.in.;
t = Thickness of plate in sixteenths of an inch;
p = Pitch of stay-bolts, in inches;
C = 120 for stays screwed through plates over $\frac{7}{16}$ in. thick with ends riveted over.

By substitution in the formula the maximum allowable working pressure is found to be

$$120 \times \frac{8 \times 8}{8 \times 8} = 120 \textit{ lb. per sq.in.}$$

Freezing Temperatures of Brine Solutions—What per cent. of salt or density of brine should be carried in the brine tank of an ammonia refrigerating system? J. M.

The density should be sufficient to prevent the brine from freezing at the temperature required in the brine tank.

The freezing temperatures of salt brine, of different densities at 60 deg. F., are as follows:

Deg. Baumé 60 Deg. F.	Specific Gravity	Per Cent. Salt by Wt.	Freezing Point, Deg. F.
1	1.007	1	31.8
5	1.037	5	25.4
10	1.073	10	18.6
15	1.115	15	12.2
19	1.150	20	6.86
23	1.191	25	1.00

The properties of calcium-chloride solutions for the same range of densities are as follows:

Deg. Baumé 60 Deg. F.	Specific Gravity	Per Cent. Ca. Cl.	Freezing Point, Deg. F.
1	1.007	1	+31.1
5.5	1.041	5	27.68
11	1.085	10	22.38
17	1.131	15	12.20
20	1.159	18	4.64
23	1.189	21	—4.90

Safeguarding Electrical Equipment*

By Walter Greenwood

Some of the matters safety engineers would like to have the Association of Iron and Steel Electrical Engineers make declaration on in some manner, so that they can be pointed to as authoritative, are comprised in the following list:

1. The general principles that should govern in the installation of automatic engine stops.
2. The general principles that should govern, for safety, in the construction of electric switches.
3. Should any low limit be fixed for voltage that is dangerous?
4. Should or should not fixed stops be placed on the tracks of runways to prevent cranes passing a given point intermediate between the ends of the runways?
5. Should the hot-metal hoist of a ladle crane be used for any other purpose than handling ladles?

1. In reference to the installation of automatic engine stops, it should not be necessary to state that bursting of flywheels, generators and turbines is taking a large toll of human lives as well as causing destruction of property; also there is the loss incidental to the stoppage of business.

There are many kinds of automatic stops in use on engines, and some kind was found to be installed in nearly every engine where the turbine or flywheel burst during the period covered by the last 10 years or more. An engine stop should, if possible, be constructed so that with ordinary attention it will not fail to operate when required, regardless of the inconvenience it may cause by operating unexpectedly by reason of its own imperfections or by failure of its operating agency.

Five cases can be cited where turbines burst, and in two of these there was dreadful loss of life. In each of these cases the turbine was equipped with an automatic controlling device that failed to prevent the explosion. There is no doubt that a properly installed independent automatic stop, electrically operated, would have prevented each of these several explosions.

Mechanically Operated Engine Controllers

No objection can be raised against mechanically operated engine controllers, and it must be admitted that they are wonderfully efficient, but they are constantly at work and history shows that they lie down on their jobs through fatigue, injury or other causes, usually unexplained or unexplainable. Then is the time a spell-hand controller is useful. Some may say if the spell hand fails at the same time, where are you? No worse off than though no spell hand was near. Such a controller as referred to can fail only through improper conditions, and it must be admitted that improper conditions can exist. It is also admitted that the mechanically operated control can fail, but with two safeguarding installations—one for a check on the other—if the chance for failure of each was one time in one month, the chance for both to fail during a simultaneous period of five minutes' duration would be one time in 730 years.

Objections are made by some to an electrically operated nonbalanced valve, because with disuse corrosion occurs or matter is deposited from the steam, which prevents closing of the valve. If this is a legitimate objection, why should not all manner of instruments employed in the industries be condemned on similar grounds? All need attention, or there would be but little employment for labor.

A reason for favoring an electrically operated unbalanced valve for stopping an engine, installed along with such other automatic device as may be desired, is that it can be operated from numerous points and any remote point if desired. The energy for operating a valve, if the instalation is properly made, is as reliable as the energy that must be depended on to operate any other kind of controlling device. Where these stops are used, an independent generating outfit connected to a wet battery should be installed in a plant of any considerable size. This would guard against failure of current, but to further insure against such failure, a switch should be supplied to automatically cut in current from some one of the most reliable circuits of the generating station in case the independent generator failed or stopped. An emergency valve should never be placed with its stem on the under side. On all engines, unless they are turbines, the cylinder oil should be fed in ahead of the emergency valve. Valves on turbines can be given sufficient lubricant to prevent corrosion or accumulation of matter around the stem, without any objection. The lubricant should be injected directly upon the valve stem in quantity so small it can have no noticeable effect on other parts of the turbine. Last but not least in the list of requirements, the energy for operating the mechanism should be supplied through a closed circuit.

2. It must be admitted that a switch should be constructed so that extreme caution will not be required for the avoidance of accidents of all kinds incidental to its use, if it can be done. It surely can be done, but operating electricians as well as designers are much at variance in regard to the importance of high-class construction, from both the efficiency and accident-prevention points of view.

One of the greatest obstructions to the introduction of switches that possess all the features necessary to make them both foolproof and efficient is that manufacturers are reluctant to engage in producing an article of high class, both in design and construction, while an inferior article can be produced, which too many electricians think is just as reliable for performing the same office.

The operating electrician should not be satisfied with a switch that does not possess the requirements necessary for economic operation. This could be possible in one that possesses all the requirements for a good safety switch.

Requirements for a Safety Switch

The interlocking feature to positively prohibit closing of circuits before closing the switch incasement, which safety men seem to think is an important feature, is of less importance than is the matter of seeing a switch in operation while inspecting it. A switch should be constructed for quick break and for quick closing, in the interests of both safety and efficiency. Switches should be inclosed with a waterproof incasement of noncombustible material.

The throw of a switch should be made from the outside of the incasement by lever or rod, so that the circuit can be closed or opened without opening the casing. Unless for a few exceptional purposes, switches should be fused on the side that is dead when the circuit is broken. Provisions should be made for locking switches open with a considerable number of locks. Perfect workmanship should be considered a very important feature in the construction of a switch.

3. Quite frequently attention is called to a case where a person has been killed by a shock from current of not more than 120 volts, and in each case it was claimed the fact was well established that the voltage could not have been higher. If the impression, true or false, that one voltage was less dangerous than another had never gained a foothold, probably a more wholesome regard would exist for the danger that might lie in any piece of wire in almost any locality.

A declaration that any voltage is dangerous might result in raising the standard for insulation of drop cords and other insulated wires or parts that necessity compels bringing a person in contact with.

4. Accidents that occur to men on crane runways are too frequent, and usually they are very serious. The situation could be made foolproof by tying the crane so that it could not move, but in regular mill practice conditions arise when operations cannot be stopped and something must be done on crane runways or in their vicinity, where the runway affords the best and sometimes the only place to stand on or the only means for getting from one point to another along the runway.

The crane operator, if he would, cannot watch the runway like a locomotive engineer watches the track in front of his train. All his attention must be given to watching below him that no accident may occur.

*Abstract from a paper presented at the eleventh annual convention of the Association of Iron and Steel Electrical Engineers, Philadelphia, Penn., Sept. 10, 1917.

Cannot the situation which forms the subject of this discussion be cared for by an arrangement of the wire installation so that a simple appliance that will break the current can be set at any point on the track, and this in turn will apply brakes to the crane? This seems like an extravagant arrangement to accomplish what can be done by compliance with a fixed order of procedure, like installing a man to guard and making provision in other ways to notify the crane operator when to move or stop. Also, this would be adding a new method for protection that might or might not be complied with, but between the two methods, stopping a crane with an obstruction that adds a new hazard and stopping it by manipulating the current, the latter should have the preference. A simple method for breaking the current would be more sure of application than installing track stops, which take time and labor for placing and removing.

The association could take a responsibility from the safety engineer by declaring for or against the practice that is the subject of this discussion.

The discussion on this paper brought out a diversity of opinion as to what is the best way of safeguarding electrical equipment. It was the opinion of many that an educational campaign among those who have to do with the apparatus would go a long way toward preventing accidents—this in preference to encumbering the equipment with a lot of so-called safety devices, which, although they may protect the operators, make the equipment very dangerous for the maintenance men to work around. On engine stops the point was brought out that the automatic stop, which should be in the form of a quick-closing valve, should be tested every 12 hours and a record of the tests kept on a log sheet, and that in addition to the automatic stops, some form of a butterfly valve should be installed in the steam line and controlled electrically from outside of the engine room. Considerable diversity of opinion existed as to the best way of protecting workmen working on crane runways. However, from the experience of several members it would seem that small track torpedoes had been about as successful as any one means.

Mr. Greenwood, in closing the discussion, pointed out that statistics show that most accidents around electrical equipment occur to experienced men, and that prevention of accidents is a matter of efficiency and efficiency alone. If the efficiency of a process is increased where one employee can do the work of two and do it better, the liability of accidents is reduced by two.

Information on Foreign Trade Methods

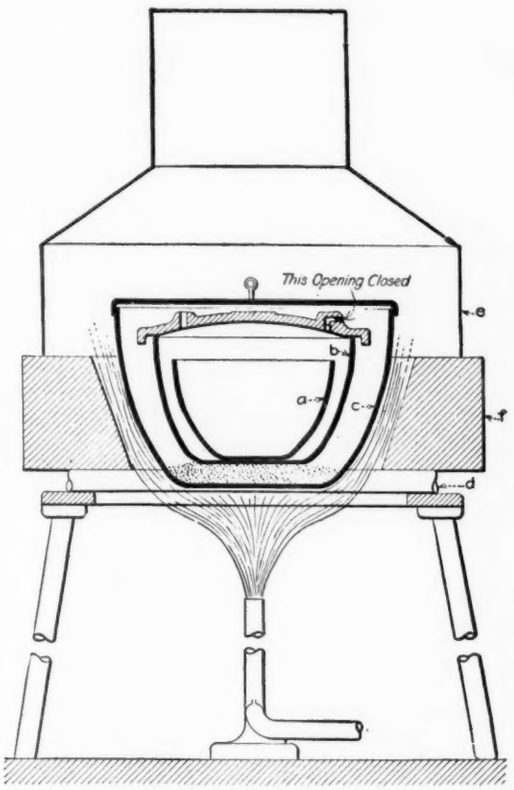
The Bureau of Foreign and Domestic Commerce has issued a report on German foreign-trade organization, by Chauncey D. Snow, assistant chief of the bureau. This report is based on personal contact with the organization and methods of commerce in Germany and other countries, but for the most part the writer's purpose was to bring together in one volume material which the bureau had already published in various special reports, with the new and pertinent statistics. In an introductory statement it is pointed out that "the German point of view with regard to foreign trade and the German system of education for foreign trade are distinctive, and the banking and transportation systems are referred to as factors in the development of the country's foreign trade. In connection with the technique of actual export shipments, it may be pointed out that this or that large American corporation with long experience in exporting uses this or that admirable method, in which it was perhaps a pioneer, and probably few phases of German export science might not be proved to be known and practiced by individual concerns in the United States, but such scientific organization is the exception with the latter; in the former it is the rule."

"In looking to the future," states the report, "the United States has many of the same problems as all the other warring nations, and our exporters have to face a period of sharp business competition in foreign countries such as, probably, has never before been met. The American business men's associations and the Government departments are alive to the importance of these matters, and upon their individual and coöperative efforts through the coming critical years will depend in a large measure the nation's future in international commerce." The report is intended not to show the American business man that he should necessarily follow German methods, but to present the facts so that he may decide which of the successful methods could be utilized to advantage under American conditions.

"German Foreign-Trade Organization, Miscellaneous Series No. 57," may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from the district offices of the Bureau of Foreign and Domestic Commerce, at 20c. each.

Proposed Tests for Lubricants

The abstract of the report of Committee D-2 on Lubricants, of the American Society for Testing Materials, that appeared on page 134 in the issue of July 24, was made from a preprint "issued primarily to stimulate written discussion" for presentation at the meeting and "subject to correction and modification" as is customary with such society meeting papers. Following are the modifications to be noted on page 135, under "Free Acid," fifth line: "Titrate while hot with *aqueous* tenth-normal alkali *free from carbonate*," etc. Under "Carbon Residue" the following explanatory footnote should have been given:



APPARATUS FOR DETERMINING CARBON RESIDUE

This method is a modification by P. H. Conradson of his original method and apparatus for Carbon Test and Ash Residue in Petroleum Lubricating Oils. See "Proceedings Eighth International Congress of Applied Chemistry," New York, September, 1912, Vol. 1, page 131. Also reprint in the *Journal of Industrial and Engineering Chemistry*, Vol. 4, No. 11, November, 1912.

The parts of the apparatus should have been lettered to conform to the text and (d) should read Triangle, pipe *stem* covered, etc. (f) Asbestos block. The opening in the cover (at the right) to be closed. The corrected illustration is reproduced.

N.A.S.E. Convention at Evansville

Continuing the report commenced in last week's issue, Thursday morning, Sept. 13, was mainly devoted to a welfare talk by delegates on "Methods of Increasing Attendance at Association Meetings" and "Simple Cost-Keeping Systems for Isolated Plants." Charles H. Bromley made a strong appeal for better educational work. Every effort should be made to stimulate a continuation and a constant broadening of the work. The association now spends from 3 to 10 per cent., but should spend 50 per cent. of its funds. The speaker recommended a national educational bureau and said that a five-thousand-dollar man should be placed in charge of the bureau supplying educational needs. A new situation created by the war has got to be faced. He spoke of the success of moving-picture lectures by various speakers, especially by outside men, and the need of lessons in deportment, so that the engineer can present his case to the employer as man to man. The question box is a great factor in maintaining interest in the affairs of the association, also monthly bulletins to keep the members posted on what the locals are doing. The appointment of a special agent to introduce the *National Engineer* among nonmember engineers to arouse their interest and draw their attention to the association was recommended. Mr. Heeger said that every local should have an index record of members, and the state secretary cards from all locals of state to assist in obtaining employment and improving positions. Making employers and prominent men honorary members had proved a big factor in holding interest. John F. Hurst talked on keeping costs in isolated plants. Simple record systems are needed in order that the wasting of resources may be avoided.

The board of trustees reported the profits of the *National Engineer* for the last year as $17,647, the largest in the history of the association. A proposition recommending the appointment of a committee of three and an appropriation of one thousand dollars to boost the membership was referred to the Ways and Means Committee. The Mileage Committee reported 309 delegates and voted 5c. per mile, amounting to $12,363.

The following recommendations of the president were presented by the Resolutions Committee: That funds be appropriated from the national treasury for license legislation when every subassociation of state pledged support of national license committee to give aid deemed proper (passed); that an educational program be undertaken to fit members, collect and compile data of plant-operating costs to be available for any engineer threatened with central-station competition (passed); that future national conventions be held in central states in order to save on mileage and conserve the funds of the association, that the treasury should maintain a balance of at least $8000 (passed).

A resolution was passed changing the color of the official button from black to red, white and blue. The convention voted that the president appoint a technical and welfare committee of three before June 15 to outline the program of the coming convention.

Business meetings were also held by the National Exhibitors' Association and by the National Ladies' Auxiliary. The Exhibitors' election of officers resulted as follows: Paul T. Payne, president; Charles Cullen, vice president; Horace Smith, treasurer; Charles Wilhoft, Thomas Green, F. N. Chapman, L. W. Brooks and Frank Martin, Executive Committee.

In the afternoon of Thursday the members and guests were taken for a steamboat ride on the Ohio River to Koehne Dam, a Federal Government project under construction a few miles below Henderson, Ky. Refreshments were served on the boat, dancing and a general good time was enjoyed. In the evening the annual entertainment under the auspices of the National Exhibitors' Association was held in the Memorial Coliseum.

At the concluding business session on Friday morning the following officers were elected: John A. Wickert, president; Roderick MacKay, vice president; Fred Raven, secretary; S. B. Force, treasurer; W. J. Reynolds, national trustee; John F. Hurst, conductor; E. G. Heeger, doorkeeper. Cincinnati was chosen as the next convention city.

DELEGATES AND THEIR GUESTS ATTENDING THE THIRTY-FIFTH ANNUAL CONVENTION

The newly elected officers were publicly installed at the opening of the grand concert and ball on Friday evening.

The convention as a whole was one of the best held in a long time. Less time than usual was devoted to routine business and a good start was made in improving the character of the sessions and making them more educational.

A.I.S.E.E. Eleventh Annual Convention

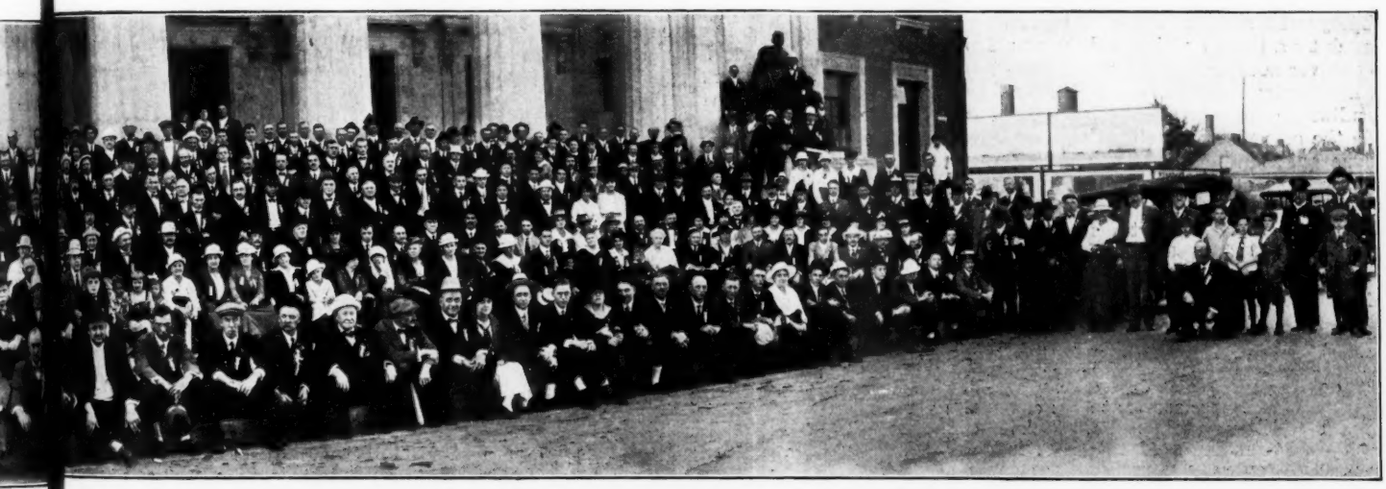
The Association of Iron and Steel Electrical Engineers held its eleventh annual convention Sept. 10-14, 1917, at the Bellevue-Stratford Hotel, Philadelphia, Penn. A business session was held on Monday morning, Sept. 10, at which the reports of the various committees were presented and the following officers for the year 1918 were elected: C. A. Menk, superintendent electrical department, Carnegie Steel Co., Homestead Works, Munhall, Penn., president; S. C. Coey, assistant superintendent mechanical and electrical department, Youngstown Sheet and Tube Co., Youngstown, Ohio, and D. M. Petty, superintendent electrical department, Bethlehem Steel Co., Bethlehem, Penn., vice presidents; J. F. Kelley, general foreman electrical department, National Tube Co., McKeesport, Penn., reëlected secretary; and G. T. Farrington, superintendent electrical department, La Belle Iron Works, Steubensville, Ohio, reëlected treasurer.

The first technical session was held Monday afternoon, with President F. D. Egan in the chair. After a few brief

remarks Mr. Egan called upon Walter Greenwood to present his paper on "Safeguarding Electrical Equipment," which was followed by a lively discussion on the safety features considered in the paper, an abstract of which appears in this issue.

The second paper, "Heroult Electric Furnaces," by Walter C. Kennedy, was presented by the author. One of the important features brought out in the discussion of this paper was the large number of electrical furnaces in use for the refining of steel in this country at the present time, the success that they have met with and the prospect for a vast increase in the use of these furnaces for metal-refining purposes.

At the Tuesday morning session two papers were presented on electrical power in the steel industry. "Factors Relating to the Economical Generation and Use of Electric Power in the Steel Industry," by Brent Wiley, was presented by the author. This paper will be published in abstract in a later issue. The second paper, "Central-Station Power Supply to Iron and Steel Industries," by Joseph McKinley and Ray L. Baker, was presented by Mr. McKinley. The authors consider the problem from the point of increased reliability by improved methods of service distribution, tying-in generating stations of the same central station and



OF THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS AT EVANSVILLE, IND.

interconnecting generating stations of neighboring companies.

At the Tuesday afternoon session D. M. Petty presented a paper on "Electric Drives for Reversing Rolling Mills." A second paper, "Electrical Reversing Blooming Mills," by Ralph D. Nye, in the absence of the author, was presented by J. H. Albricht. One of the points that the discussion on these papers centered around was the advisability of using a compound winding on the polepieces of direct-current motors employed on this type of drive, the preponderance of opinion being that the series winding was unnecessary as it did not accomplish what was expected of it—namely, prevent shock to the machinery—and furthermore, the motor already had a compensating winding in the pole faces which accomplished all that could be expected of the series winding, only in a better way.

The Wednesday morning session was devoted to a consideration of fuel economy and prime movers for steel-mill power plants. J. G. Worker presented a paper on "Fuel Economy by Coöperation in Establishing a Better Practice in the Operation of Stokers and Boilers," and R. H. Rice a paper on "Turbo-Generators." These papers will be published in abstract in a later issue.

At the Wednesday afternoon session E. H. Martindale presented a paper on "Manufacture, Selection and Use of Carbon Brushes." This paper reviews the early history of the carbon brush, the problem involved in the development and successful application of carbon brushes to electrical machinery, the serious conditions arising from the lack of standardization of brush sizes and a brief review of the troubles that are caused by wrong brushes or that cause poor operation of brushes. After the technical session of the afternoon a patriotic meeting was held, at which H. Brinker, of Lehigh University; E. J. Cattell, statistician for the City of Philadelphia; Walter Greenwood, a member of the G. A. R., and Col. J. M. Andrews, of the New York infantry, took part.

On Wednesday evening the association held its annual banquet at the Bellevue-Stratford Hotel; members and their friends to the number of 461 attended. Gano Dunn, president of J. G. White Engineering Co., was toastmaster. Addresses were made by F. D. Egan, president of the association; Hon. Theodore E. Burton, United States Senator from Ohio; E. J. Cattell, statistician for the City of Philadelphia; J. B. Finley, member of the National Chamber of Commerce; and Thomas Raeburn, member of the League for the Enforcement of Peace. Music was furnished by the Midvale Steel Co. band.

The morning and afternoon sessions on Thursday were devoted to a consideration of the Standardization Committees' reports and recommendations. It is the purpose of the committees to adopt the standardization rules of the American Institute of Electrical Engineers and those of the Power Club in so far as these rules will meet the needs of the iron and steel electrical engineers, and to formulate such other rules as deemed necessary. At the morning session the discussion centered chiefly around the standardization of electric motors. It was held by several that motors of different manufacturers for doing the same work should be interchangeable, and some of the members felt that standardization should be carried so as to include interchangeability of parts. However, it was decided to leave the matter of the adoption of the rules on motor standards to the board of directors.

The afternoon session was devoted to standardization of crane controllers and specifications and standards for electric overhead traveling cranes. The standard specifications submitted by the committee, when modified according to various recommendations brought out during the discussion, will probably be accepted by the association and be known as the "Standard Specifications for Electric Overhead Traveling Cranes of the Association of Iron and Steel Electrical Engineers."

At the last technical session, which was held Friday morning, two papers were presented: "Grab-Bucket Coal Hoists Operated by Alternating-Current Motors with Dynamic Braking and Regenerative Braking," by James Farrington and R. H. McLain; and "Tool-Steel Gears and Pinions for Mill and Industrial Service," by E. S. Sawtelle. After the technical session the members and their friends. through the courtesy of the Allen Wood Steel Co., were given an automobile trip from Philadelphia to Valley Forge, where a chicken and waffle dinner was served at the Washington Inn. On the return trip the plant of the Allen Wood Steel

Co. was visited as well as the country estate of R. C. Wood, president of the company, where the visiting party was royally entertained for a short time.

The convention was the most successful ever held by the association. Approximately 350 members and guests registered. This is remarkable when it is considered that the membership is only about 700. The average attendance at the meetings was 125.

Atmospheric Conditions Involving Risk

BY CHESLA C. SHERLOCK

It is a well-recognized rule in the law of compensation that injuries are not compensative which are suffered as the result of a risk common to the whole community. In order for a workman to recover under the compensation acts he must have received his injury by accident through an extraordinary hazard to which he is exposed by reason of his employment. If a workman passes along the street on his way to work and is injured by an automobile, he cannot recover compensation because the risk of being run over was no greater in his instance than it was to any other person who might have passed along the street. But if the workman is being transported to and from work by his employer as a part of his contract of employment, and is struck by a train and injured, he would probably be entitled to recover because the injury arose out of and in the course of his employment. The risk incurred in this instance was peculiar to the employment, although one ordinarily outside the scope of his work.

The question of whether or not compensation is recoverable because of injuries suffered by reason of atmospheric conditions is one that has caused some little disagreement among the authorities. It has been said that injuries arising out of acts of God, such as lightning or sunstroke, are not compensable because they are a hazard common to all, but this is not entirely true. The California Commission has stated the better rule as follows:

As a general rule, injuries which are suffered from the so-called acts of God, such as sunstroke, freezing, lightning, etc., do not arise out of the employment of the injured employee, for the reason that such casualties are risks which the whole citizenry takes. Where, however, the risk of the employee for injuries of this sort is clearly greater than that of the average person in the same community, then such special exposure to the danger causes the accident, if it occurs, to arise out of the employment.

In another California case the workman was employed as a lineman in a power substation. During a severe storm he went out with a fellow-employee to repair damage done to the company's wires and was frozen to death. The commission, in awarding compensation to the widow, said:

Where an employee was frozen to death while performing service growing out of and incidental to his employment and was acting within the line of his duty or course of his employment as such, and the nature of his employment and his duties in connection therewith carried with them greater exposure and the necessity of greater exposure to risk than would ordinarily be the case with persons not so employed in the zone of severe elemental disturbances, there is shown a direct connection between the death of such employee and the employment in which he was engaged, and his dependent is entitled to death benefits as for accidental death.

If a workman is working in a street and suffers a sunstroke, he is not entitled to compensation for the reason that there is no special hazard to sunstroke arising out of the employment that is not common to all. But if the workman is repairing a metal roof on a hot day, there is a special risk to sunstroke arising by reason of the employment, and if he suffers such injury, he is entitled to compensation.

In a New York case compensation was awarded a workman who lost the great toe of his right foot by freezing while engaged in log rolling. In another case the same commission awarded compensation to a workman who was engaged in cutting ice. His mittens accidentally became wet and froze to his hand, necessitating the amputation of four fingers. Inasmuch as the hazard of the employment was greater than that to which the community was exposed, compensation was awarded.

Where a workman was working in a superheated warehouse handling bags of cement and was prostrated by the heat, compensation was awarded. It was shown that the warehouse was a frame structure with a metal roof, having no windows. The cement bags were piled within one or two feet of the roof. The thermometer registered 105 in the shade. The commission held that the employee was entitled to compensation for the reason that he was subjected to a greater risk than the average person, his employment taking him into the superheated warehouse, where the exposure to the injury suffered was manifestly magnified.

In cases where an employee is struck by lightning where the hazard to lightning is no greater by reason of his employment than it is to another person outside the employment, no compensation should be awarded. But if the workman is performing services for his employer in places where he is peculiarly subjected to lightning hazard, he should receive compensation.

If a workman is, by reason of his employment, subjected to unusually stormy weather and contracts pneumonia, he is entitled to compensation. Where the hazard or exposure is no greater than that ordinarily incurred by persons outside the employment, the reverse is true.

Where an employee is exposed to unusual heat by reason of his employment, as, for instance, the fireman in a blast furnace, compensation is recoverable. The same is true where the exposure is to cold. In a given case an employee working in a candy factory was required to work in the so-called "cool room," where the temperature was maintained several degreees cooler than the outside temperature in order that the candy might be in a satisfactory state for packing. The Massachusetts board awarded compensation to the employee who, by reason of exposure, suffered paralysis of one side of the face.

While atmospheric conditions, as a rule, are held not to produce accidents within the meaning of the compensation acts when injury results to a workman, still there are many instances where compensation is properly due.

The entire question at stake in cases of this nature is whether or not there were unusual hazards to which the employee was subjected by reason of the employment. If so, then they are held to produce accidents and are compensable.

Ammonia Pipe Bursts

On the morning of Sept. 10 the bursting of an ammonia liquid line belonging to the direct-expansion refrigerating system in the Planters Hotel, St. Louis, resulted in serious injury to three of the hotel employees, besides causing a mild panic among the guests. The ruptured pipe line is of ¾-in. size and runs from the liquid receiver in the basement to the main floor, where it feeds a number of refrigerating coils in the kitchen, café and storerooms. The failure occurred at a point in the basement where the pipe turns upward in a long-radius bend to the floor above, and was caused by external corrosion. The main liquid lines in this system are incased in the same coverings with the corresponding suction lines, the two pipes being bound together, so that the insulating material comes in all-around contact with neither of them. Thus it was that breaks in the covering near the point of rupture in this case had opened a channel for admission of moisture-laden air, and so the alternate frosting and melting off of the suction pipe kept the neighboring section of the liquid pipe constantly bathed in moisture. As a result the pipe was eaten away in spots almost to the thinness of stovepipe iron.

Power Company's Manager's Authority

The general manager and president of a power company had no implied authority to bind the company by promising a prospective customer that the plant would be enlarged to increase its capacity, but he could bind the company by assuring a customer that the company would not take on any more business than it could handle. (Vermont Supreme Court, Roben vs. Ryegate Light and Power Co., 100 Atlantic Reporter, 768.)

New Publications

PUBLIC SERVICE COMMISSIONER'S NINTH ANNUAL REPORT

The report of the Public Service Commission for the second district of the State of New York for the year ended December, 1915, has just been issued. The volume is bound in cloth, has 340 9 x 12-in. pages and contains abstracts of the reports of electrical, gas, telegraph, telephone and steam corporations. Under the heading "Electrical and Gas Corporations" the report gives the nature of the service, principal officers, principal office, corporate changes during the year 1915 and control of the electrical and gas companies under the commission's jurisdiction. The balance sheet for Dec. 31, 1915, income and corporate surplus on deficit accounts year ended Dec. 31, 1915, miscellaneous investment, fixed capital, funded debt, funded debt issued or assumed, capital stocks, capital stocks issued, operating revenues, operating statistics, municipal street lighting, accidents to persons, are set forth in tabulated form for the electrical corporations, electrical and gas corporations, coal-gas and water-gas corporations, natural-gas corporations and municipal electric plants under the control of the commission. These companies are divided into A, B and C classes. Class A includes those whose operating revenues for the three years next preceding that covered by the last report of the commission averaged over $25,000 per annum; Class B those whose operating revenues averaged between $25,000 and $10,000 per annum for the same period; Class C those whose operating revenues were less than $10,000 for the same period. A statement is given of the nature of the service, principal officers, principal office, corporate changes during the year 1915, and control of the telegraph corporations, telephone corporations and telegraph and cable corporations operating within the State of New York. The financial status of the companies is given in a form similar to that for the electrical and gas corporations. The report closes with a three-page statement on the twelve steam corporations coming under the jurisdiction of the commission.

Personals

Thomas Ewing has resigned as Commissioner of Patents to resume his law practice in New York City.

Monroe J. Frankel has been appointed gas and electrical inspector of Louisville, Tenn., succeeding R. M. Parks, deceased.

E. H. Martindale, sales engineer of the National Carbon Co., Cleveland, Ohio, has been made a captain in the Engineer Officers' Reserve Corps.

F. R. Bacon, president of the Cutler-Hammer Manufacturing Co., Milwaukee, Wis., has been made a captain in the Quartermaster's Department.

A. N. Diehl, assistant general superintendent of the Duquesne works of the Carnegie Steel Co., has been appointed assistant to the vice president of the company.

F. L. Webster, formerly district manager for Allis-Chalmers Co. at San Francisco, is now district manager of the company's Chicago office, succeeding F. Von Schlegell, resigned.

D. R. Shearer, formerly engineer for the Boone Fork Lumber Co., of Shulls Mills, N. C., has opened consulting-engineering offices in the Burrow Building, Johnson City, Tenn.

F. W. Gay, recently Pacific Coast correspondent of the J. G. White Engineering Corporation, is now in New York City as Atlantic district manager for the Pelton Water Wheel Co.

Edward T. Morre, formerly with the Westinghouse Electric and Manufacturing Co., is now electrical engineer with the Halcomb Steel Co. and Syracuse Crucible Steel Co., Syracuse, N. Y.

J. W. Swaren, engineer with the Pelton Water Wheel Co., San Francisco, is now a captain in the Engineer Officers' Reserve Corps and is on duty as instructor at the Vancouver (Wash.) barracks.

N. Merion, formerly connected with the power sales department of the Westinghouse Electric and Manufacturing Co., is now in the engineering and construction department of the Duquesne Light Co., of Pittsburgh, Penn.

C. D. Powell, formerly connected with the engineering department of the Westinghouse Electric and Manufacturing Co., has resigned to accept a position as works manager of the Scientific Products Co., of Steubenville, Ohio, whose factory is at New Cumberland, W. Va.

P. A. E. Armstrong has resigned as manager and vice president of the General Steel Co., Milwaukee, Wis., and has accepted vice presidency of the Ludlum Steel Co., Watervliet, N. Y., which is said to be producing greater tonnage of electric tool and alloy steel than any other steel works in this country.

John B. Redd, formerly industrial engineer of the Pacific Gas and Electric Co. of San Francisco, is now in Los Angeles to establish a branch of the Davis-Bournonville Co., with which concern he is now connected. Mr. Redd is the man who succeeded in quickly and effectively patching up the wrecked German ships here. His knowledge of welding and cutting apparatus is widely recognized.

E. B. Hotchkiss, of the American Steel Export Co., sailed Aug. 28 on the steamship "Chicago" for France, Italy and Spain, where he will make certain investigations for the American Steel Export Co. and also act as a special representative of its engineering department in that part of the world. Mr. Hotchkiss resided in France and Belgium for over nineteen years and during that time had charge of and was responsible for a large number of important engineering works.

Obituary

James White, one of the best-known and oldest of boiler inspectors in this part of the country, was killed in a boiler explosion at Porto Rico on Sept. 18.

Royal C. Peabody, of Brooklyn, president of the Combustion Engineering Co., died at his summer home at Lake George, on Sept. 15. He was born in Columbus, Ga., in 1854. He went to Brooklyn with his parents in 1865 and began a business life at the age of 13. He spent three years in the U. S. Navy, and after that time until his death he kept up his activities on large and varied lines. He was the organizer and first secretary of the Brooklyn Illuminating Co., and vice president at the time of its absorption by the Kings County Electric Lighting Co. He was a leader in Brooklyn civic life and a member of many clubs. He is survived by a married daughter and a son.

Miscellaneous News

The Boiler at the Sawmill owned by T. A. Stanley, near Milburn, Ky., exploded during lunch hour on Sept 11. The owner suffered injuries of which he died later, and his two sons were seriously injured. The cause of the accident is not known.

R. S. Rainsford, district manager of inspection, Aircraft Engineering Division, Signal Corps for New York, appeals for applicants for this service. Graduate engineers and men with shop experience are preferred. Mr. Rainsford may be reached care of J. G. White Co., 43 Exchange Place, New York City.

The Research Corporation of New York offers an annual fellowship of $2500 to encourage scientific research directed to helping the industrial arts. Those desiring to compete must fill out an application form, which will be furnished by the secretary of the corporation, and file it before Oct. 1, 1917.

The Milwaukee Electric Railway and Light Co. has recently placed with the Locomotive Pulverized Fuel Co. a contract to equip with apparatus for the burning of pulverized fuel, 2500 hp. of boilers at its Oneida St. plant. This is the first central-station plant to be so equipped and the largest equipment for burning powdered coal under boilers ever furnished.

Two Large Water Power Developments are now under way in France, brought about by war needs as well as the scarcity of coal. One installation of 20,000 hp. will use water from the Alps; another development of 50,000 hp. in the southwest will use water from the lakes and rivers of the Pyrenees. Previous to the war factories were very scarce in this region, but now there are numerous works engaged in making munitions.

Undeveloped Water-Power Resources in the State of Washington—At a recent luncheon of the Spokane (Wash.) Chamber of Commerce, Carl F. Uhden, chief engineer of Washington Water Power Co., gave an illustrated lecture on the water-power resources of the Inland Empire. He said there are about 250,000 hp. now developed and at least 2,000,000 still undeveloped. The cost of furnishing the power is estimated at $25 per year per horsepower for manufacturing purposes. The views shown included the power plants of the company in Spokane with 15,000 hp. capacity, the Long Lake plant with 45,000 hp. capacity, and the Little Falls plant with 36,000 hp. capacity.

A Committee to be known as "War Committee of Technical Societies," has recently been organized by the Engineering Council. The function of the committee is to act as intermediary or means of communication, when desired, in matters relating to science, research, invention and engineering between the Army and Navy, the various Boards, Councils, Committees and other agencies of the Government and the membership of the societies represented, for the purpose of presenting problems to the members of the technical societies, and of obtaining their ideas and suggestions. The Committee's headquarters is at 33 West 39th St., New York City.

The New York School of Heating and Ventilating announces the opening of the fifth annual season, 1917-18, on Monday and Wednesday evenings at 7:30, at Room 512, World Building. The first-year class will meet on Monday evenings, for which has been outlined a course of 18 lectures. The second-year class will meet on Wednesday evenings, for which a course of 12 lectures has been outlined. Both classes will be under the direction of Charles A. Fuller consulting engineer, with Clark, MacMullen & Riley. The fee for each complete course will be $15, payable in advance. The first meeting for registration in both classes will be held on Monday, Oct. 1, and the first session of the advanced class on Wednesday, Oct. 3.

The Nitrate Supply Committee appointed by the Secretary of War to investigate the matter of the Government production of nitrates and other products has recommended that the Government enter into negotiations with the General Chemical Co. to acquire the rights to use the synthetic ammonia process of that company and that a sum estimated at $3,000,000 be placed at the disposal of the War Department to be used in building a plant of a capacity of 60,000 lb. of ammonia per 24-hour day; that the Government proceed at the earliest practical date with the construction of a plant at an estimated cost of $600,000 for the oxidation of ammonia to nitric acid, of a capacity of 24,000 lb. of 100 per cent. nitric acid per 24-hour day. The location of the proposed plants has not been made public. The committee also recommends a contract with the Nitrogen Products Co. for the use of the Bucher process for the production of sodium cyanide and ammonia. The immediate accumulation and permanent maintenance of a reserve of not less than 500,000 tons of Chile saltpeter is urged.

Engineering Affairs

The Smoke Prevention Association will hold its annual convention at Columbus, Ohio, Sept. 25-27.

The Third National Exposition of Chemical Industries will be held at Grand Central Palace, New York City, Sept. 24-29.

The Engineers' Club of Philadelphia will hold a joint meeting with the American Society of Mechanical Engineers on Oct. 16, at the club rooms at Witherspoon Hall.

The Engineers' Club of Philadelphia will hold a joint meeting with the American Institute of Electrical Engineers at the club rooms, Witherspoon Hall, on Nov. 20.

The New York Association of the American Society of Refrigerating Engineers will meet at the Machinery Club, 50 Church St., New York City, on the evening of Sept. 27. A paper on "Transfer of Heat from Air to Pipes," by Charles H. Herter, will be read and discussed. The dinner will begin promptly at 6:30 p.m., and the meeting at 8 p.m.

The American Association of Engineers, at a recent meeting of its board of directors, granted charters to the members in St. Paul, Indianapolis and Milwaukee. This makes a total of seven chapters established in the organization since its incorporation two years ago. At a joint meeting of the association and the Detroit Engineering Society on Aug. 30, it was the unanimous opinion of all present that the two organizations should coöperate, as the Detroit society carried out locally a similar program to that which the other organization operated in a national way.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Sept. 22, 1917	One Year Ago	Sept. 22, 1917	One Year Ago
Buckwheat ..	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Sept. 22, 1917	One Year Ago	Sept. 22, 1917	One Year Ago
Clearfields ...	$4.15—4.50	$1.15—1.75	$8.00—8.35	$4.25—5.00
Cambrias and Somersets...	4.40—4.75	1.45—1.90	8.25—8.50	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4.02—4.19, as compared with $2.85—2.90 a year ago; on cars Boston price is $8.75—9.00.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Sept. 22, 1917	One Year Ago	Sept. 22, 1917	One Year Ago
Buckwheat ..	$3.95—4.65	$2.75	$4.75—5.00	$2.75—3.00
Rice	3.40—3.60	2.20	3.25—3.40	2.10—2.20
Barley	2.90—3.15	1.95	2.35—2.50	1.85—1.95

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. Sept. 22, 1917	Mine Prices One Year Ago
Bunker coal	$6.00—6.25	$4.00—4.50
Commercial	5.25—6.00*	3.00

*Based on Federal Trade Commission suggestion.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Sept. 22, 1917	One Year Ago	Sept. 22, 1917	One Year Ago
Buckwheat ...	$2.90	$1.65	$3.80	$2.55
Rice	2.40	1.00	3.40	1.90
Boiler	2.20	.90	3.30	1.80
Barley	1.90	.75	2.15	1.65

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Sept. 22, 1917	One Year Ago
Slack	$3.00—3.25	$1.20—1.40
Mine-run	3.00—3.25	1.65—1.75
¾-in.	3.50—3.75	1.75—1.85

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump ..	$2.20	$2.20	$2.25	$2.20	$2.20
Lump	2.20	2.20	2.25	2.20	2.20
Egg	2.20	2.20	2.25	2.20	2.20
Nut	2.20	2.20	....	2.20	2.20
No. 1 nut....	2.20	2.20	....	2.20	2.20
No. 2 nut....	2.20	2.20	....	2.20	2.20
No. 3 nut....	2.20	2.20	....	....	....
No. 1 washed.	2.20	2.20	....	....	....
No. 2 washed.	2.20	2.20	....	....	....
Mine-run	1.95	1.95	2.10	1.95	1.95
Screenings	1.75	1.70	1.90	1.70	1.70

Hocking lump, $2.60; splint lump, $2.40.

Northern Illinois thin vein—Prepared sizes, $2.65; mine-run, $2.40; screenings, $2.15.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Sept. 22, 1917	One Year Ago	Sept. 22, 1917	One Year Ago	Sept. 22, 1917	One Year Ago
6-in. lump ..	$2.20	$2.00	$2.20*	$1.75	$2.20	$1.65
2-in. lump..	2.20	1.50	2.20*	1.40	2.20	1.10
Steam egg...	2.20	1.50	2.20*	1.40	2.20	1.10
Mine-run ...	1.95	1.40	1.95*	1.25	1.95	1.15
No. 1 nut..	2.20	1.60	2.20*	1.75	2.20	1.25
2-in. screen.	1.70	1.00	1.70*	1.00	1.70	.90
No. 5 washed	1.70	.90	1.70*	.75	1.70	.75

*Strike.

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Mobile—The Kelly-Atkinson Constr. Co., 189 West Madison St., Chicago, plans to build a power plant in connection with its new shipbuilding plant here. W. L. Kelly, Pres.

Calif., National City—The San Diego Consolidated Gas and Electric Co. plans to issue $837,500 bonds, the proceeds to be used for improvements. W. Wiggins, Engr.

Colo., Denver—The Denver Gas and Electric Light Co., 1300 Zuni St., has been granted a permit and plans to build a brick boiler plant. Estimated cost, $56,000.

Fla., Palm Beach—Town plans to appropriate $50,000 to improve and extend its street-lighting system.

Fla., Tampa—The Tampa Electric Co., 810 Tampa St., has increased its capital stock from $2,618,000 to $2,879,800, the proceeds to be used for extensions. J. Orr, Engr.

Ill., Waukegan—City Council plans to install an electric-light plant and waterworks system. E. V. Orvis, Comr.

Mass., Boston—Bureau Supplies and Accounts, Navy Dept., Wash., soon receives bids furnishing at Navy Yard, Boston, under Schedule No. 1474, switchboard type ammeters.

Mass., New Bedford—The Union Street Railway Co. plans to build a 80x115-ft. brick power station to meet the increased demands upon its generating capacity. Estimated cost, $1,000,000.

Mo., Kansas City—The Kansas City Light and Power Co., 1500 Grand Ave., has purchased a 25-acre site in the East Bottoms, and plans to build a new power plant.

Mont., Big Timber—City Council plans to install an electric street-lighting system.

Mont., Terry—City plans to install an electric-light system.

N. J., Bordentown—City Commission has purchased a site at Mile Hollow and plans to build an electric light plant and coal trestle. A. Garrison, Mayor.

N. J., Newark—The Oxweld Acetylene Co., 646 Frelinghuysen Ave., plans to build an addition to its power plant.

N. J., Plainfield—The Niles-Bement-Pond Co. has had plans prepared for a 1-story power plant.

N. Y., Buffalo—The Buffalo General Electric Co., Electric Bldg., plans to build an addition to its power plant on River Rd. P. F. Sellers, Gen. Supt.

N. Y., Buffalo—The Curtiss Aeroplane & Motor Co., 1738 Elmwood Ave., plans to build a 1-story, brick and steel power plant.

N. C., Walnut Cove—M. A. Walker & Co. plans to rebuild its boiler and engine house recently destroyed by fire.

Ohio, Bluffton—E. Reichenbach, City Clk., has sold $35,000 worth of bonds, the proceeds to be used in extending and improving the electric-light, power and waterworks system.

Ohio, Cleveland—City plans to build an addition to its lighting plant. Estimated cost, $1,223,000. R. Hoffman, City Engr.

Penn., Glen Olden—H. K. Mulford Co. is having plans prepared for a 20 x 50-ft. boiler plant.

Penn., Halifax—The State Water Supply Commission has granted the Millersburg Electric Co., Millersburg, permission to build a transmission line from here to New Buffalo by way of Clemson Island.

Penn., Harrisburg—The Harrisburg Railways Co., 12 South Market St., is planning to build a new substation.

Penn., Lancaster—The Edison Electric Co. has been granted permission by the Public Service Commission to issue $230,000 in bonds, the proceeds to be used in extensions and improvements.

Penn., Philadelphia—The Atlantic Refining Co., 245 North 30th St., plans to build a 1-story power house addition to its plant on 36th St. and Jackson Ave. Estimated cost, $22,000.

Penn., Philadelphia—The Industrial Foundry & Machine Co. plans to build a new boiler house.

Penn., Philadelphia—The Philadelphia Suburban Gas & Electric Co., West Washington Sq., plans to issue $168,000 in bonds, the proceeds to be used for extensions. R. C. Cornish, Ch. Engr.

Penn., Pittsburgh—The Mahoning & Shenango Railway & Light Co., Youngstown, has been granted permission by the Public Service Commission to issue $500,000 in bonds, the proceeds to be used for extensions and improvements.

Rhode Island, Providence—The Narragansett Electric Lighting Co., 76 Turks Head Bldg., plans to issue $1,700,000 in capital stock, the proceeds to be used in extensions and improvements.

Tenn., Nashville—City Commissioners plan a $55,000 bond issue to improve the electric-light plant. W. W. Southgate, City Engr.

W. Va., Ashland—City Council plans to install a new street-lighting system. Estimated cost, $150,000.